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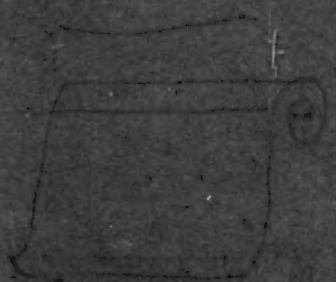

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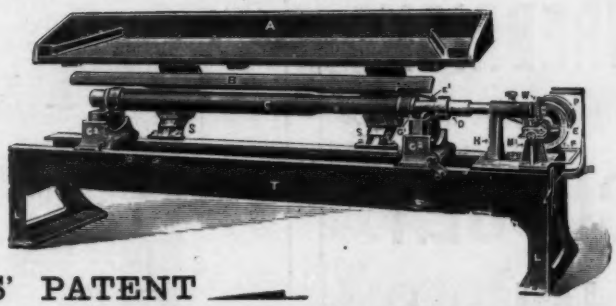

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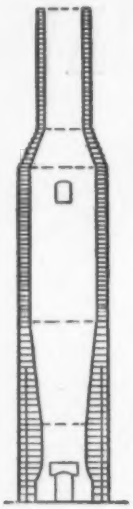

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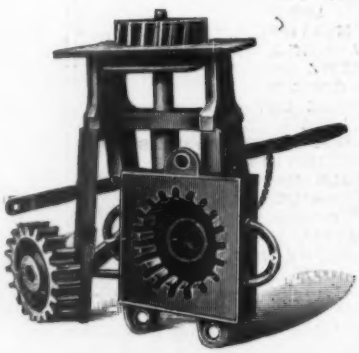

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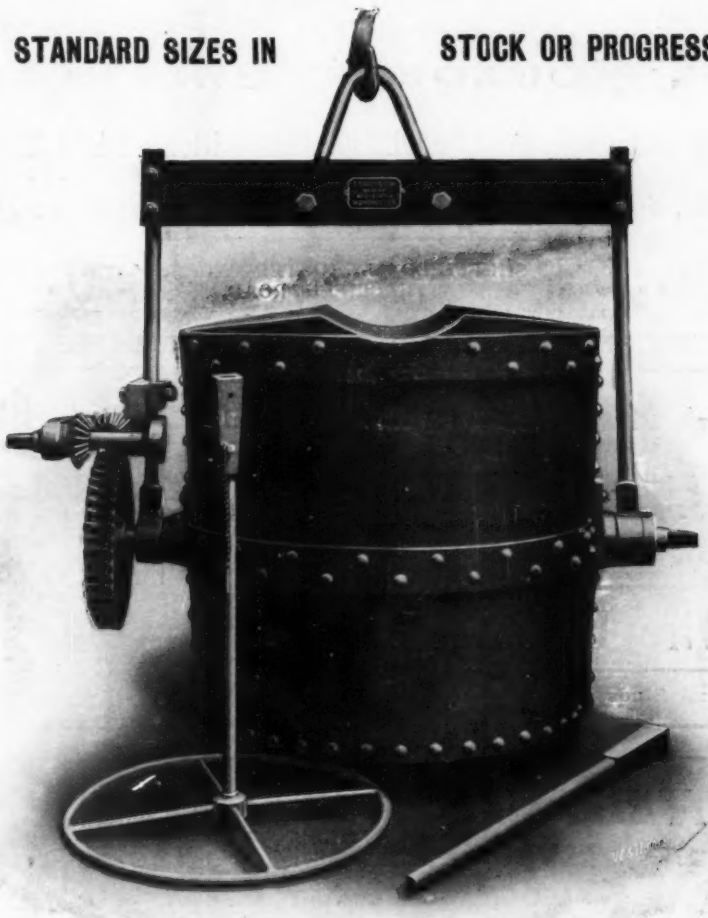

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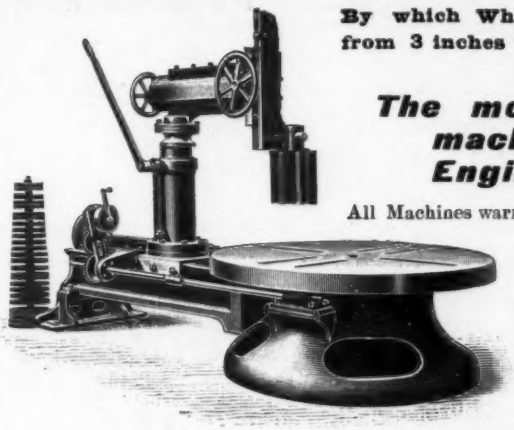

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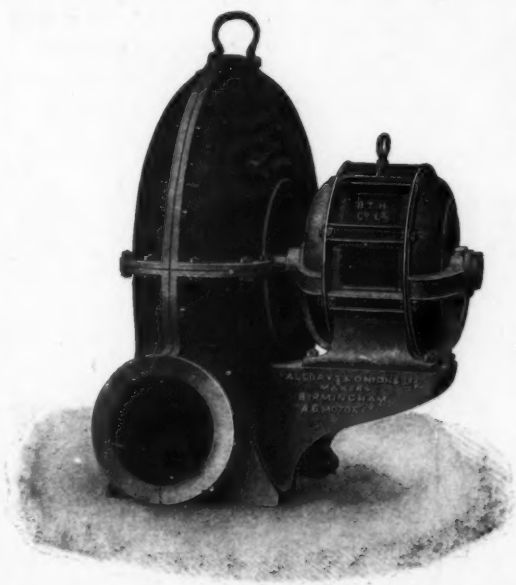

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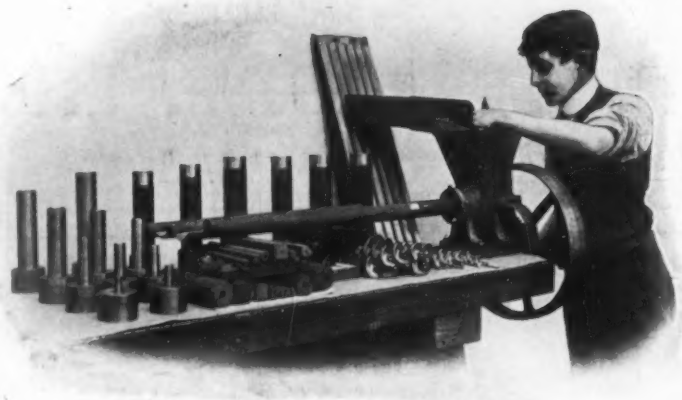

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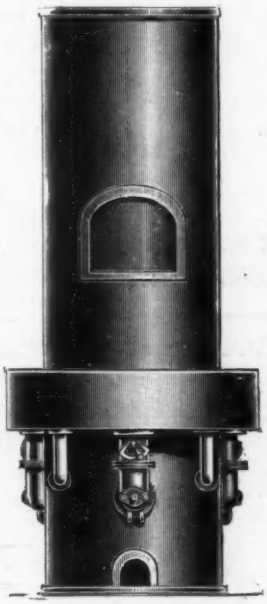

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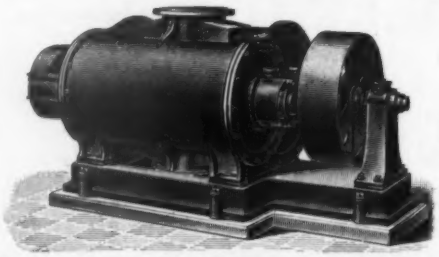

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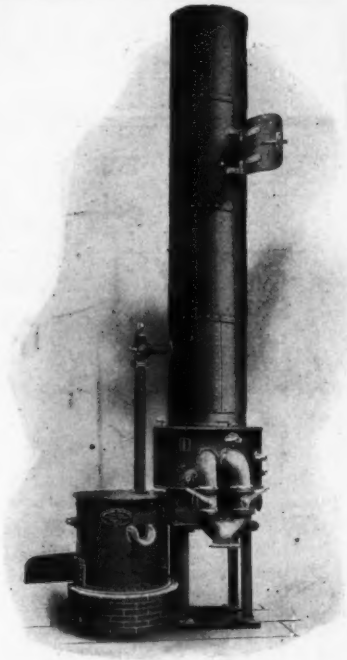

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Vol. 11. **JANUARY, 1909.** **No. 85.**

PUBLISHED THE FIRST WEEK IN EACH MONTH.

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JANUARY 16.

British Foundrymen's Association (Lancashire Branch).—"Foundry Tests of Pig-Iron," Mr. F. J. Cook.

JANUARY 20.

Birmingham Metallurgical Society.—Visit to Messrs. F. H. Lloyd & Co., Ltd., James Bridge.

JANUARY 29.

Birmingham Metallurgical Society.—"On the Static and Dynamic Testing of Materials," Prof. J. O. Arnold, M.A.

FEBRUARY 6.

British Foundrymen's Association (Lancashire Branch).—"The Pattern-maker: His Work and its Relation to Allied Trades," Mr. Flitcroft (Bolton).

NOTES AND COMMENTS.

The Moulding Machine and the Handy Man.

At the annual Convention of the National Founders' Association, at New York, which we note elsewhere, Commissioner M. C. Clintock, commenting on this subject, said:—

"Since the moulders' strike of 1906 the handy man and specialty moulder have been a factor of increasing importance in the foundry. The extended use of this class of labour in foundries making high-grade machinery castings was at that time brought about more by necessity than by choice. The result was, the brains of the pattern shop and drafting departments were turned to the foundry as never before. Every pattern on which the expense of fitting could be saved in a year or less was altered to go on a moulding machine. Other jobs were changed in ingenious ways to eliminate so far as possible the skill required in moulding. Perhaps the pattern was simply fitted on a board to insure the parting line and assist in drawing the pattern. The effort was toward making it possible quickly to teach unskilled men to produce castings. Changes made in patterns and rigging reduced many important jobs to a point where but little moulding skill was necessary; the time of moulding was cut down, and a great saving was made in cost."

"The quickest and simplest method of convincing foundry foremen that improvements can be made in their methods of shop practice is to go with them on a trip of inspection to shops which are using handy men and moulding machines on high-grade work. Moulding machines have been recently introduced in a large number of shops, and are being successfully operated by labourers. With the machine, castings of a more uniform character are produced and in greatly increased quantities. This has been done in shops where two years ago it was thought impossible. Not long ago I visited a shop where they were making on machines gas-engine cylinders of all sizes up to 25 in. in diameter, and weighing about 3½ tons each. The flask required was 6 ft. by 7 ft. and 26 in. deep in cope and drag alike. The ramming was done by the machine, the operation requiring less than five minutes. The pattern was drawn by a crane, the match plate being guided by pins. Two labourers operated the machine, while an apprentice boy set the cores and closed the moulds. I was informed that as very few pieces were made off one pattern at a time, the patterns were changed from four to ten times a day. The castings produced were pronounced equal to any ever made by the firm.

"In another shop the manager stated that they had introduced 14 machines in the past year, and for many months kept four pattern-makers doing nothing but fitting patterns for moulding machines. By the use of handy men they are getting fine results. Each machine will do the work of at least three moulders,

and on all patterns fitted up to the present the machine-moulding has reduced the labour cost fully 50 per cent. In addition to this, they found quite a saving in the machine shop, as the castings being uniform would fit the jigs and could be handled rapidly."

Ferro-Silicon in the Foundry.

In the opening address of Professor A. E. Outerbridge, Jun., President of the Mining and Metallurgical Section of the Franklin Institute, Philadelphia, U.S.A., the speaker remarked that in 1905 he announced before the Metallurgical Section of the Institute a new discovery in the treatment of cast iron while in the molten state, after it had been withdrawn from the melting furnace, whereby the strength was increased and at the same time the ordinary brittleness and hardness of cast iron was largely eliminated. The process consists simply in adding to the molten metal, just before pouring it into the moulds, a very small quantity of an alloy containing 50 per cent. or more of the element called silicon. This alloy, a comparatively new product now being made in the electric furnaces with intense heat, was at first only used for treating molten steel in quite a different way and for a totally different purpose. At the time the announcement was made, three years ago, there was practically no demand for the alloy in the six or seven thousand foundries in America engaged in making iron castings, but since the publication, in 1905, of the results of the speaker's experiments and investigations with "Ferro-Silicon in the Foundry," a rapidly increasing use for the high-grade silicon alloy in iron foundries in America, and also in Europe, had sprung up, the beneficial effects being found greater than was at first claimed.

The "Flexilis" and "Bosshardt" Casting Processes.

On another page we publish particulars of the "Bosshardt" casting process, which in many respects bears a striking resemblance to the "Flexilis" process described by Mr. E. C. Ongely before the West of Scotland Iron and Steel Institute (see FOUNDRY TRADE JOURNAL, June, 1908). Both processes aim at the production of castings that, without any annealing or kindred treatment, are quite malleable and capable of being used in place of wrought-iron and forged work.

When publishing the description of the "Flexilis" process we commented on the fact that certain additions to the molten metal were not specified, particulars being withheld by the author. In the case of the "Bosshardt" process also, the nature of certain additions to the molten metal is not stated, and thus it is impossible to say just what relation they bear to each other. But in other respects both appear to work on practically the same lines. The raw material in each case is scrap wrought iron; for the "Flexilis" scrap nails, bolts, chippings, and punchings of plates is stipulated, while for the "Bosshardt," the material is waste iron and steel bolts, rivets, nails, horseshoes, chains, ends of bars, etc. A furnace of special construction for melting in crucibles is used in both processes, though, while the "Flexilis" employs plumbago for the crucibles on account of the great heat necessary, the "Bosshardt" overcomes the difficulty by the use of a special refractory coating.

For the former process the metal is prevented from burning into the moulds by a suitable addition of refractory materials, gannister, etc., and in the latter process by the special refractory coating just referred to. The "Flexilis" requires the addition of certain materials to the metal in the crucibles after the fusion, the composition and amount being adjustable according to the required result, and in the other case also, chemicals are added during fusion to "purify and impart the necessary qualities." A similar range of qualities apparently is produced by each process; Mr. Ongely mentions a forgeable quality, a forgeable and weldable quality, mild steel and hard steel, while the "Bosshardt" description states a soft forge quality which is readily malleable, extra soft steel, soft steel and hard tool steel. When it is remembered that the distinction between a malleable cast iron and mild steel is extremely vague, it will be recognised that these descriptions of qualities approach very closely to each other. As regards the temperature at which these processes are carried out, the former requires 2,700 degrees F., and the latter 2,000 degrees C.; both being extremely high. This, of course, is accounted for by the nature of the raw material. The "Flexilis" process is stated to be in operation at about eighteen Continental works, while the "Bosshardt," we are told, has been in use at works in France and Holland for four years. Finally, the cost of producing the castings, inclusive of plant and upkeep, is in each case approximately the same. While a comparison of these particulars would suggest that both processes are based on the same essentials, it is quite possible each has, nevertheless, its distinctive features. In any case we can only wish success to any process that presents a solution to the difficulties, and is a means of ending the troubles that accompany the annealing at present in vogue. The interest displayed by our readers (as evidenced by enquiries for more particulars) points to a good opening for such processes, provided they can be operated as economically as the methods in general use at present.

The British representatives of the "Bosshardt" process inform us that they are not aware of any connection between their process and the one described by Mr. Ongely, and it is therefore not for us to suggest that they are allied except in-so-far as they attain a similar end. As we have already said, there may be essential differences in the treatment of the molten metal, giving each process distinctive features. But we are safe in saying that any further information, as it becomes available, will be welcomed with interest by foundrymen.

Comparison of Foundry Coke.

In the course of a discussion on "factors" in coke consumption at a meeting of Birmingham foundrymen, Mr. G. Hailstone quoted analyses of various brands of coke with a view to showing their suitability or the reverse for foundry use. It must, of course, be borne in mind that this comparison is not necessarily representative of the brands of coke mentioned; the considerable variations in the constituent percentages which will often occur in different deliveries make it extremely difficult to give a really representative analysis that will serve as a guide to users. The basis specification which Mr. Hailstone lays down of ash maximum 8.0 per cent., sulphur maximum 0.75 per cent., and fixed carbon minimum 88 per cent., will, we think, be generally accepted as a sound one, but as he acknowledges, all cokes outside the range of this specification are not to be regarded as unsuitable for use in the foundry; they often possess characteristics which especially adapt them for certain purposes. No founder would desire a higher percentage of sulphur in his coke than that laid down in the specification, but we must admit that many users have turned out good work with fuel that did not come within the prescribed limits. So much depends on the conditions of working and the material charged, that each foundry must be governed by its

own circumstances; the question of price also is an important factor. In view of these variations in the analyses of the same make of coke over a period, each delivery should stand more or less on its own merits; though, of course, the average of, say, six months' analyses of one brand would give a good idea as to its general suitability for the cupola. This we would suggest as being a reasonable basis on which to compile a comparison table; an analysis of individual deliveries which might or might not be representative of the general run of coke of the same brand might prove very misleading to those who accepted it as a standard, and who chose to be guided by it. Owing to the natures of the coals used for coking, and the style of oven employed by different makers, each brand will be particularly liable to certain characteristics, which add to or detract from its value for particular purposes. But it is difficult to lay down any rule beyond a general one of desirable limitations as to constituents.

A Foundry Problem.

A correspondent, raising a point which has probably caused a good deal of trouble to various foundrymen, writes to the following effect:—

The writer wishes to bring before the foundryman the folly of using mixtures of iron and alloys of metals, as given in books written by scientific men and foundry experts, unless the directions for using them and the points to be guarded against are also given. Practical men, as a rule, earn their livelihood by having found out, not the mixture, but how to manipulate it. Most ironfounders have some particular mixture or mixtures of iron to which they attach great importance. They have learned by years of experience how to use certain combinations of irons to give the best results in the castings. In a recent book on foundry work, great things are told about the addition of steel scrap—ship-plates, for instance. The good to be derived is in the lowering of the silicon without raising the sulphur content. Now, this would be a help to the iron founder if it worked out as expressed in the book. It allows the use of cheaper pig-irons in place of high-priced cold-blast pig-irons for hydraulic work, etc. The book goes on to say: "What a difference this 20 per cent. of steel scrap makes to a low silicon, low sulphur mixture, for after bringing it in we can select among pigs containing over 2 per cent. of silicon for the remainder and get perfect analyses, so to speak:—Silicon, 1.60 per cent.; manganese, 0.82 per cent.; sulphur, 0.062 per cent.; phosphorus, 0.60 per cent." Now, even Mr. Buchanan would not say 99 per cent. of this mixture would come out right if he were to use it in the way it is put in the book, and yet the analysis is above reproach.

The writer of the book adds:—"The calculations show the nature—as to composition, at any rate—of the beneficial effect of steel scrap in cupola charges." There is not the slightest doubt steel scrap is beneficial, but there is a particular way to use it, and had these directions been given with the mixture, many would have been saved trouble in trying it.

Spretson says:—"When a tough, close-grained casting is required, borings and turnings of wrought iron are often put in the cupola along with the broken pig. Morris Stirling had a process of making tough iron, which consisted in putting pieces of wrought iron along with pig-iron and passing them through the furnace." But if Morris Stirling got a good, close, tough iron, it doesn't follow that another man would, even with the same ingredients, unless he knew the way how to manipulate it.

With regard to the steel scrap problem, the President of the British Foundrymen's Association says: "I have had some experience with this, and I find it a rather dangerous thing." Mr. P. Munnoch says: "Steel scrap added to the charge is used, to some extent, for reducing carbon and increasing strength. The results obtained vary considerably, owing to the uncertainty of the resulting carbon content. The resulting metal is also in a more or less oxidised condition, which may cause trouble in the foundry."

The writer is of the opinion that if the manipulation of this scrap steel had been given with the mixture, it would have been possible to obtain a product equal, or superior, to some mixtures of cold-blast iron. One gentleman, who has been trying it, remarks: "Unless you get hold of the right quality of steel borings you are likely to reduce, rather than to increase, the strength." This trouble is not the quality, but a black magnetic oxide formed by the steel being burned at the temperature of the furnace. To overcome this, "patent medicines" to help to dioxidise the metal are often advised, but they also lower the profits, for they are expensive remedies, and none should be required.

W. J. Keep tells us that when the amount of steel scrap exceeds 10 per cent., a very small quantity of aluminium should be used in the ladle to increase fluidity. Common casting aluminium should not be used, as it produces irregular results.

Scientific writers and speakers, who are trying to eliminate the old rule-of-thumb practice from the foundry, should be careful in giving these mixtures to point out where the user must be careful, and if the manipulation is not known, leave out the mixture. So much depends on the manipulation of each separate mixture that without some definite guidance the foundryman is very liable to encounter complete failure with what would otherwise give excellent results.

NORWEGIAN OUTPUT AND EXPORT OF IRON ORE.—According to the "Teknish Ugeblad," the output and export of Norwegian iron ore has been as follows in the years named:—

	Output. Tons.	Export. Tons.
1901	42,250	39,170
1902	53,670	48,770
1903	53,470	41,570
1904	45,350	45,400
1905	61,500	60,550
1906	99,000	81,400
1907	130,000	137,600

SPANISH MINERAL PRODUCTION IN 1907.—The production of certain minerals in Spain during 1907 is given in the following table, the figures being official statistics quoted by the November report of the British Chamber of Commerce for Spain. The corresponding figures for 1906 are added for comparison:—

——	1906.	1907.
	Metric Tons.	Metric Tons.
Iron ore	9,448,533	10,072,709
Copper and copper pyrites	2,888,777	3,376,041
Lead	105,095	276,021
,, (argentiferous)	158,424	15,541
Zinc	170,383	126,351‡
Manganite	†	33,916
Graphite	—	2,473
Tin	86*	294
Wolfram	†	163

* Dressed ore. † Information not available.
‡ Blende and calamine.

The Institute of Metals.

First Meeting in Birmingham.

The first meeting of the recently-formed Institute of Metals was held in the Technical School, Birmingham, on Wednesday and Thursday, November 11 and 12, 1908. There was a large attendance, strong contingents being present from London, Manchester, Sheffield and other metal-working centres. During the proceedings it was announced that the membership had reached 330.

The first President, Sir William White, K.C.B., F.R.S., was accompanied on the platform by the Lord Mayor (Mr. George H. Kenrick), and the leading officers of the Institute, Professor Turner (Hon. Treasurer), Mr. Baeddiker (Chairman of the Local Committee), Mr. Poppleton, Mr. W. H. Johnson and Dr. H. C. H. Carpenter (Hon. Secretaries), with the Secretary, Mr. G. Shaw-Scott.

The LORD MAYOR (who is himself largely interested in important metal trades) offered to the Institute an exceedingly hearty welcome. It seemed to him singularly appropriate that they should be meeting in that room which had been associated in Birmingham to a very considerable extent with those metals with which they were chiefly interested.

SIR WILLIAM WHITE, on behalf of the officers and members, said the courtesy shown by the Corporation in placing that beautiful hall at their disposal and helping them in so many ways deserved their heartiest gratitude, while they had also to thank the Lord Mayor for his sympathetic and suggestive speech of welcome. He should like to record also their appreciation of the work done by the leaders of the Local Committee.

Greeting from the American Brassfounders' Association.

The SECRETARY read the following letter:—

American Brassfounders' Association.
Office of Secretary,
Detroit, Michigan, Oct. 5, 1908.

To Mr. William H. Johnson (Hon. Secretary),
Institute of Metals.

DEAR SIR,—I wish to extend the greetings of our Association to the Institute of Metals at this your first General Meeting, and we sincerely hope that your efforts have proven successful, and that the response to your call for members has been both generous and hearty. Our Association stands ready and willing to help in any way that is in its power, and shall be glad to render service as an organisation or as individuals whenever the opportunity presents itself.

One thought that I should like to throw out as a starter for some helpful work is this: the compilation of standard methods for the analysis of brass. We feel the need of this kind of work here, and have discussed the appointing of a committee to prepare the way for the work. We have a very good example of such work in that of the American Foundrymen's Association with iron and steel. The value of similar methods for brass can hardly be over-estimated. This is a subject that both our organisations would do well to investigate, and one that is sure to be productive of results.

Wishing you every success,
I am, with kind regards,
Yours very truly,
W. M. CORSE (Secretary).

The letter was received with applause, as was also the reply which Mr. Johnson had sent to Mr. Corse, and which was as follows:—

DEAR SIR,—I beg to thank you on behalf of the Institute for your kind letter of greetings from the American Brassfounders' Association to the Institute of Metals, at their first General Meeting, and also thank you for your readiness to render us any help in your power. You will be pleased to hear that we have arranged for the first General Meeting of members to be held in Birmingham, which, you are doubtless aware, is perhaps more than any other city the centre of the general brass industry of Great Britain. The meeting will occupy two days. A variety of papers will be read, and I trust that short as the notice is we may have some American representatives present. I think your suggestion as to the compilation of standard methods for the analysis of brass is an excellent one, and Dr. Carpenter, my co-Honorary Secretary, and our Treasurer (Professor Turner), will give their attention to this.

With best thanks for your brotherly greetings, which will be read before the Birmingham meeting,

Believe me,
Yours truly,
W. H. JOHNSON (Honorary Secretary).

PRESIDENTIAL ADDRESS.

The PRESIDENT (Sir William White) then delivered his inaugural address, in the course of which he remarked that the Institute might be described as another step in the direction of inevitable specialisation. Its founders were confident its existence would be justified by its work, and that its operations would not interfere with the continued success of its predecessors, but it would rather have a beneficial effect upon them. Dealing with the rules, Sir William pointed out that the first clause referred only to the promotion of community of interest and information, and the second alluded specifically to the fact that the Institute was intended also to promote free communication between the metal trade and users of non-ferrous metals. As regarded the latter class, he ventured to assert that no less importance attached to the interchange of information between manufacturers. No one could doubt that frank conference and discussion, such as the Institute would encourage, might lead to a reconsideration of many conclusions hitherto regarded as definite and final. At present many difficulties and failures which occurred in the use of metals arose from causes that remained obscure and demanded thorough investigation. He was sanguine enough to believe that the establishment of the Institute would promote the growth of the scientific spirit; and in the end would lead to better conditions, to freer and more cordial intercourse, to united effort for improvement on the part of makers and users, and to the universal conviction that all classes must be benefited by encouragement of research and the freest publication of results obtained which circumstances might permit. If they were to succeed in this endeavour, the proceedings of the Institute must embrace contributions from users as well as makers of non-ferrous metals and their alloys; and there must be friendly discussion between the two classes when difficulties had to be faced and doubts removed.

The cordial collaboration of members of the Institute whose interest in metals was chiefly of a scientific character was one of the most important guarantees of their success. The range and variety of possible

researches into the properties of non-ferrous metals and their alloys was so great that there was scope for all classes of investigators. Members who engaged in special departments of metallurgical work, and found themselves confronted with difficulties, or discovered promising avenues for further advance which they could not themselves penetrate, would do good service to make themselves known, in order that the problems consequent thereon might be attacked by men having the ability and opportunity for research work. Users of metals should also contribute to the programme of investigations to be made.

On the motion of MR. G. A. BAEDDIKER, seconded by MR. W. MILLS, a cordial vote of thanks was accorded to the President for his address.

The PRESIDENT acknowledged the vote of thanks, and with regard to the procedure of the Institute explained that the discussion of the papers read in Birmingham would be continued if necessary at the next meeting, which would take place in London on the 19th and 20th of January.

Election of Officers.

The following gentlemen were nominated by the Interim Council as Vice-Presidents:—Mr. J. D. Bonner, Mr. N. Cookson, Professor Gowland, F.R.S., Mr. Gerard Muntz, Admiral Oram, and Sir Henry Wiggin, Bart.

On the motion of the PRESIDENT, seconded by MR. ADAMSON, these were unanimously elected.

The PRESIDENT announced that the election of members without entrance fee would be continued until June 30, as the financial year had been fixed to commence on July 1.

Copper and Copper Alloys.

MR. J. MILTON then read a paper on "Copper and Copper Alloys," in the course of which he remarked that information was needed on the two following points. It was well-known what a great influence "work" had on the quality of steel forgings and rolled material. It should also be known what the effect of similar work was, either "hot" or "cold," on copper, and what was the minimum amount of work which should be put on the material either by hot or cold rolling or drawing in order to convert the unreliable casting into reliable plates, sheets, or tubes. Another question was the proper way to effect annealing, and what was the result of this operation. Mr. Milton also referred to copper-zinc alloys, and pointed out that cases were frequently met with in which they were far from reliable or durable. In regard to gun-metal castings, reliable data was wanted as to the effect on the strength and ductility of different temperatures, at least up to the highest temperature at which they were likely to be used for boiler mountings; and they also required to know the effect at these various temperatures of such impurities as were often found with so-called "gun metals." White metals for lining bearings also offered a very wide field of research.

The PRESIDENT said that the anticipations he had expressed as to Mr. Milton's paper had been fully justified.

MR. JOHNSON referred to an instance of copper piping that would not withstand the slightest bending, but to which subsequent treatment by annealing had restored its original properties. Probably that was due to the fact that too much work had been done upon the metal. There could be little doubt that the times and temperatures in annealing were in need of standardisation. He knew a case in which the difference of a short time in the furnace had altered the tensile strength which had been 14.24 tons to the square inch to 15.12, a very important difference, because one was under and the other was above a certain trade classification.

MR. REED remarked that it might be within the knowledge of many of them that copper heated in a reducing atmosphere for a considerable time assumed the condition which was described as "gassed," in which all its ductility was practically lost, so that on forging it broke and crushed in the most unsatisfactory manner.

DR. CECIL H. DESCH said that the effect of cold-rolling copper was confined to a mere skin on the outer surface. In the case of some copper rods which had been used as spindles for stirring apparatus in chemical tanks, these stood perfectly well, but bars of exactly the same metal exposed to the air rapidly fell to pieces; though under examination there was no corrosion to be traced by the microscope, the surface of the metal was in a state of extreme strain.

The PRESIDENT, in announcing that the time allotted had expired, hoped that the discussion would be continued when the paper was brought up again at the London meeting.

Mechanism of the Annealing Process for Certain Copper Alloys.

A paper on the above subject by MR. G. D. BENGOUGH and MR. G. F. HUDSON, was next read by Mr. Hudson. The paper was an attempt to lay before the Institute a summary of the knowledge that has been acquired up to the present of the rationale of the annealing process, incorporating with it an account of the authors' own work on the subject, some of which has already been published.

The PRESIDENT said that the paper to some extent answered the questions put by Mr. Milton. That Institute, while desiring to be associated with the National Physical Laboratory in its work, was equally desirous of being associated with the laboratories which in universities like that of Birmingham were dealing with physical questions.

This terminated Wednesday's proceedings so far as the reading and discussion of papers was concerned.

In the afternoon the members paid a visit of inspection to the University New Buildings at Edgbaston, where they were received by Professor Sir Oliver Lodge, F.R.S.

In the evening there was a Reception of the members by the Lord Mayor, followed by a Conversazione and exhibition of objects of metallurgical interest.

THURSDAY'S DISCUSSION.

The General Meeting was resumed on Thursday, when several papers were read and discussed.

Mechanism of the Annealing Process for Certain Copper Alloys.

In opening the discussion on the above paper by Messrs G. D. Bengough and G. F. Hudson, PROFESSOR TURNER said that he was very pleased to have an opportunity of saying a word or two in reference to the paper, because Mr. Hudson was associated with him in the University of Birmingham, while Mr. Bengough was also a well-known member of the University staff before he accepted the appointment of Lecturer on Metallurgy in Liverpool. Some five or six years ago he (Professor Turner) had been delivering in Mason College a course of lectures on "Brass," which were very largely attended by the brassworkers of the district. Very shortly after that an abstract of Mr. Shepherd's paper appeared in the "Journal" of the

Society of Chemical Industry. He (the speaker) discussed the matter with Mr. Hudson, and the question arose as to whether Shepherd was right or wrong, because if he were right then certainly what they had thought before was wrong. The evidence in favour of Shepherd's statement was so slight that Mr. Hudson thought it advisable to commence a series of experiments to see whether the equilibrium curve given was trustworthy. His experiments went to prove that they could depend upon the results of Shepherd's work. Other investigators had followed on similar lines, and up to now, with some slight modifications introduced into the diagram, Shepherd's curve was, he thought, universally acknowledged as the basis of our study of copper alloys, and particularly of Muntz's metal. They had heard, therefore, that day a discussion of the heat treatment of Muntz's metal in a language with which they were entirely unacquainted five or six years ago. That showed the importance of keeping themselves reasonably abreast with the times, and with modern methods of viewing alloys. If a man at the present time was to understand anything about heat treatment of either zinc-copper or tin-copper alloys, he must know the equilibrium diagram and whether he was dealing with material perfectly homogeneous or with a mixture of metals which would separate itself out at certain critical temperatures, or could be reduced by rapid annealing. The paper was very full of valuable information, which would be of great importance as they had time to digest it more fully.

The PRESIDENT, having thanked the authors of the paper, adjourned the discussion to the London meeting.

Aluminium and Some of its Uses.

MR. J. T. W. ECHEVARRI then read his paper on the above subject, a full abstract of which will appear in our next issue.

The PRESIDENT having expressed the thanks of the members to the author, said that this paper would also have to stand over for more detailed discussion in London, but they had a few minutes available for remarks upon it.

MR. BONNER said that it was well that this paper had been read before the Institute, because the subject was likely to occupy considerable attention in years to come. It was well, too, that the paper had been read in Birmingham, because that city had attained to such prominence in other branches of metallurgy that he was hoping it would be equally to the fore in the future developments in the aluminium industry. That industry had undergone a complete transformation. The large producers came some years ago to the decision that they would look in the future rather to a large turnover than to selling the then comparatively small production at high prices, and consequently a good profit. Therefore, the producers incurred considerable expense in developing the new water-powers which were essential to the production of the metal with a view to putting it on the market permanently at a very much lower price than it had reached up to that time. The result of these extensions was that aluminium to-day was selling at about half the average price of the seven years previously. It was important that it should be known that there was not any real likelihood of a material increase in the price—or of any near approximation to the old price—ever again recurring in normal times. Anyone who thought he saw an opening in aluminium might feel perfect confidence in going ahead and counting upon a cheap supply. They all knew that at one time there was a pool in aluminium, but they foresaw that that pool would be over when the big works that were then being erected should be completed. The result, in fact, had been to bring down the prices permanently to those which now prevailed.

DR. H. C. H. CARPENTER, dealing with the concluding portion of the paper relating to the properties of alloys of aluminium, more particularly the alloys with copper, said that the authors stated that among the objections against their possible use were the difficulties and cost of working, and also the question of expense. Of course, he had nothing to do with the question of expense, but the objections with regard to the cost of working, so far as his own experience went, did not seem to be well founded—more particularly with regard to alloys which were rich in copper, for example, 95 per cent. copper and 5 per cent. aluminium. With these they had had little difficulty in the works where the alloys were rolled cold—difficulties with regard to rolling, forging, and so on. On reading that paper, and also the able paper by Mr. Phillips, it occurred to him that there were alloys of aluminium and copper that might very properly be tried where alloys of copper and zinc and copper and tin were now being used. To his mind alloys containing, say, 6 to 9½ or 10 per cent. of aluminium would repay further investigation upon a commercial scale.

The PRESIDENT said that speaking from his own experience in these alloys, he was still hopeful for aluminium, still hopeful that something not quite so weak as pure aluminium would be placed at the disposal of shipbuilders, something which would contain the properties of the metal, and yet be capable of resisting the action of sea water. Whether that would be realised or not he could not say, but until such a material could be found the use of aluminium for ships must be very much restricted. He hoped that when the discussion was resumed in London they would be afforded further information upon the many aspects of this interesting question.

Notes on Phosphor Bronze.

A paper on the above subject, read by Mr. Philip, will be found on another page.

MR. PHILIP, referring to an investigation he had made as to the origin and history of phosphor bronze alloys, said a phosphor-bronze company came into existence in 1875 or 1876. There was a paper published in a technical magazine with a letter from Dr. Percy, and, as far as he could ascertain, phosphorus for copper, and probably copper-tin alloys, was first investigated and used practically by his predecessor at the Admiralty, Mr. Weston.

The PRESIDENT thanked Mr. Philip for his valuable paper and for the light he had thrown upon the history of phosphor bronze. They had also, the President added, to thank the Admiralty for their courtesy in allowing the publication of the results quoted by Mr. Philip. The President went on to say that of his own knowledge there was a period in the history of phosphor bronze earlier even than that associated by Mr. Philip with the name of Mr. Weston. It was connected with an Admiralty metallurgist, Mr. Farquharson, who, being much concerned with the practical tests of copper, began the investigation. Mr. Weston, as the chemist, naturally became charged with the work of investigation, but it was only right that the work done by Mr. Farquharson should also be remembered. But he (the President) could go even further back. When he was a student in the Royal School of Naval Architecture, from 1864 to 1867, Dr. Percy was then Lecturer in Metallurgy, and in 1865 gave a lecture in which he alluded to the great effect upon copper alloys of the presence of small quantities of

phosphorus. This was in a course of lectures on copper sheathing for wooden ships. Mr. Philip had pointed out that the Admiralty concerned itself with the metals as they were delivered, and did not insist upon specific compositions, except as the result of experience. During his connection with the Admiralty that was the practice with regard to steel for armour-plates and other things, and with non-ferrous metals and alloys. They allowed absolute freedom to the maker in determining the processes and chemical composition of the metal or the alloy. That, he believed, was the proper relation that should exist between the user and the maker. The purchaser had the right to make sure that within reasonable and proper limits the actual delivery was in accordance with the specifications, but there was a distinction between that and the arbitrary laying-down by the purchaser of conditions as to chemical composition and processes of manufacture. He had always been opposed to the user taking the place of the manufacturer, or the manufacturer attempting to dictate to the user. The purchaser had the right to say what he wanted and what its qualities should be, but he had no right to invade the province of the manufacturer.

Mr. Chas. F. Gaywood said the paper was of great interest, and he hoped it would have the effect of standardising specifications and tests for phosphor bronze. The chief direction in which the producer of those alloys had developed in the past appeared to have been in the introduction of imitations. These had been called into being, partly for the sake of cheapness of castings, but more on account of a desire on the part of the majority of engineers for a metal which would machine more easily and keep down workshop costs. Phosphor bronze was in first cost an expensive material, not only owing to the high cost of the ingredients, but also to the cost of working it owing to its hardness and toughness. The modern craze for reducing costs was opposed to the use of anything which was likely to increase them. Therefore, if something was not done to fix the standard of phosphor bronze, the name would continue to be used to represent all kinds of mixed metals. Phosphor bronze should be produced from the very purest of ingredients, as impurities exercised a very pronounced effect upon the metal. It would be readily understood that owing to the affinity of phosphorus for oxygen, the use of scrap copper—which always contained a considerable amount of oxide—was prohibited, as it would rob the mixture of phosphorus, or cause it to be retained in a form in which instead of strengthening the metal, weakened it. When it was realised what a small amount of phosphorus altered the properties of the resulting alloy, it would be readily understood how great a variation might be produced by the presence of oxides in the metal used in the manufacture of phosphor bronze. With regard to the relations between manufacturers and users, he was very much in favour of the retention of physical tests by the Admiralty. A maker might produce a phosphor bronze which would analyse quite satisfactorily, and yet the metal might be absolutely rotten because of its heat treatment.

The President: I meant, of course, physical and mechanical tests.

Mr. Gaywood, continuing, said that while a chemist might find the constituents correct, the microscope might prove that the metal had not the required properties. He thought the microscope much more dependable than analysis.

The President thought Mr. Gaywood might be said to have adjourned the discussion to the London meeting. They hoped that he would be able to continue it there.

Plant Used in the Manufacture of Tubes.

Mr. W. H. A. Robertson read a paper on the above subject.

Mr. Gerard Muntz, of Muntz's Metal Company, remarked that it was something like bringing coals to Newcastle to read a paper in Birmingham on the manufacture of tubes. There were many points of interest in the paper. He thought their discussions were intended to bring the scientists and the practical man into more intimate association. The scientist, no doubt, could tell the practical man how to overcome the difficulties he met with. On the other hand, there were many troubles, many diseases in the metal they manufactured, which they were practically acquainted with, and the scientist and the practical man could each contribute something to the solution. At present there was too large a gap between the scientific and the practical side, and he wanted to see that narrowed down.

Mr. Vaughan Hughes suggested that in future time should be given to answer any questions that might be put. He would like to know also whether written communications would be allowed.

The President said he proposed to consult with the Council on that matter. They hoped to find time for everyone to speak. With regard to contributions, they hoped to have a number of valuable ones, but they would be submitted to the Educational Committee, who would have the supervision of that department.

Mr. Hughes further suggested that they might have some sort of arrangement by which the micrographs could be published in definite sizes.

The President said on that point they would take the opinion of gentlemen most competent to advise the Education Committee.

Mr. Cookson rather demurred to the suggestion made by Mr. Muntz that the scientist should tell manufacturers how to remedy certain evils. He thought that was quite outside the province of the scientist. The research man gave them the information, and having done that he thought the cobbler should stick to his last.

The President said he hoped Mr. Muntz would, in London, put the views he had expressed in a somewhat more amplified form. Continuing, he said they had now come to the end of what he thought might be called a very successful meeting. The attendance had been admirable, and quite beyond what could have been expected. They had benefited greatly through holding the meeting in Birmingham, not merely because of the large membership, but because of the kind hospitality they had received. Sir William White concluded by moving a resolution of thanks to the Lord Mayor, the Principal and authorities of the University of Birmingham, who had acted on the initiative of Professor Turner, to the Committee and Staff of the Technical School for the use of the hall and committee rooms, and to the firms who had given permission to the members to visit their works. He regretted that owing to an old injury to the knee he could not join them in those visits. They were much indebted to Mr. Baeddiker, Mr. Poppleton, and the local committee.

Mr. W. Rosenhain seconded, and Mr. W. H. Johnson (Hon. Secretary) supported, the latter remarking that he thought the Institute would be of the greatest possible service in the interests of scientific research, and to those interested in metallurgy generally, as well as to manufacturers who so earnestly desired to improve their methods. It was no longer true that English manufacturers relied on rule of thumb.

The resolution was carried with acclamation.

The President then called attention to a sugges-

tion made on the previous day by a member of the meeting that for the first year they should double their subscriptions. There was some reason in that, inasmuch as they would not have to pay entrance fee, which subsequent members would have to do. The gentleman making the suggestion had led the way in carrying it out. He would leave the matter in their hands. He hoped they would attend in London in large numbers and be prepared to take part in the discussion.

On the proposition of PROFESSOR TURNER, seconded by MR. BAEDDIKER, a hearty vote of thanks was accorded the President, who briefly acknowledged the compliment.

Visits to Works.

The afternoon was spent in visits to the following works:—The Birmingham Aluminium Castings (1903) Company, Limited; the Birmingham Small Arms Company, Limited; the Birmingham Metal and Munitions Company, Limited; Messrs. James Cartland & Sons, Limited, brassfounders; Earle, Bourne & Company, Limited, metal rollers; Elkington & Company, electro-platers; Joseph Gillott & Company, penmakers; Muntz Metal Company, Limited, metal rollers, etc.; H. Wiggin & Company, nickel rollers, etc.; and the Wolseley Tool and Motor Car Company, Limited.

The Use of Gas in the Foundry.

At the autumn meeting of the Southern District Association of Gas Engineers and Managers, held in London recently, a paper entitled "Applications of Gas for Industrial Purposes," was read by Mr. E. C. Riley, of Swindon.

In introducing his subject MR. RILEY explained that his illustrations were taken chiefly from the works of the Great Western Railway Company at Swindon, which include plant for the manufacture and repair of locomotives, carriages, wagons, and various types of vehicles and machinery required in railway working. The gas works supplying the workshops and depôt had been enlarged and remodelled from time to time to meet the growing needs of the Great Western Railway Company, and from a bench of coke ovens supplying coke for smiths' fires and boilers, as well as gas for lighting, constructed in the early forties, it had grown into an up-to-date well laid-out gasworks, with regenerative settings, convenient quenching and coke-loading arrangements, well-appointed engine room with direct-driven steam exhausting plant, a three-lift spiral-guided holder in steel tank, methane-hydrogen plant, and would shortly have in use a "Sturtevant" fan driven by steam turbine for raising pressure in the main supplying gas for the various industrial uses and for ten gas engines, six of which were three-cylinder vertical "Westinghouse" engines capable of working up to 250 and 300 h.p. The latter were employed generating electric current for power purposes; motors being fixed to the various machines, cranes, etc., which were fed with current simply by ordinary copper wire leads, so saving the extensive system of shafting, pulleys, and belts necessary under the old arrangements.

Heating Core-drying Ovens.

Referring to the application of gas to the heating of foundry core ovens—brick chambers 24 ft. by 14 ft. by 10 ft.—the lecturer said these had previously been heated by flues from a special coke or coal furnace which had been kept going as near as possible to a constant temperature for a week or longer for drying cores for castings. It was found to be difficult to keep the heat as regular as desired, owing to the variations in stoking, or the character of the coal or coke, or even variations in the wind, and sometimes in the stoker on duty. An oven was accordingly fitted up as a trial with gas burners placed into an arrangement of organ-like distributing pipes. Good results were immediately obtained, as the heat was constantly uniform and under perfect control. After working for a time the pipe arrangement for distributing the heat was removed to make room for some cores, when it was found the oven heated as well, if not better—without the heat distributing pipes—with a long bunsen burner, placed in the bottom corner, made of 2-in. pipe, 20 ft. long. This, laid in the open oven near the floor, was perfectly effectual.

The cost of heating by gas was more than the cost of coal for fuel; but when the improved work and saving of labour and reliability were considered the advantage was distinctly in favour of the gas, and

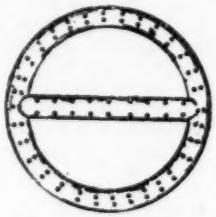


FIG. 1.—A SIMPLE BURNER.

this method is now the only one in use. It was possible to fill the ovens with cores, say, at night, and, according to size and character, to adjust the gas to have them dry at the required time next day. On Saturdays, also, the oven could be filled in the morning before the men finished work, and the gas again adjusted so that the work would be ready for Monday morning.

Drying Foundry Moulds.

Apart from the core-drying oven, all the apparatus described are supplied with gas and blast. The advantages of blast depend upon the manner in which the application of the heat is required. A striking instance was the trial of an American patented arrangement for drying moulds by a combination of gas and blast. But after a number of competitive trials, this device was superseded by a simple arrangement of bunsen burner consisting of gas and air at the ordinary pressure; the latter arrangement using only 63 per cent. of the gas employed in the pressure apparatus, doing the work in half the time, and without any payment of royalty to inventors—the difference being that a general diffused heat is required instead of a fierce concentrated heat. Fig. 1 shows a burner of this type which is used for drying moulds and the sand linings of the ladles in which the liquid iron is carried from the cupola furnaces to the moulds.

Steel Castings from the Electric Furnace.

The Bonner Fräserfabrik G.m.b.H., of Bonn, in addition to producing high-carbon tool steel and high-speed steel for milling tools, also makes a very mild, malleable cast steel (S=0.08 to 0.18 per cent.) which is largely used for small machine parts, especially for motor car work. In fact, this branch has now become far more important than the tool steel one, in point of quantity; and the steel process offers the advantage of rapid production, there being no need for annealing the castings. The metal is distinguished by a high elongation value, *e.g.*, 25 per cent., with a breaking strength of 59,700 to 64,000 lbs. per square inch. A number of the castings are shown in Figs. 3 to 9. Until quite recently the crucible furnace alone was employed for producing these castings from Swedish wrought iron (so-called Lancashire iron) worth about £10 per ton, the best Swedish charcoal pig-iron being used in the case of tool steel. The crucibles were very expensive, being necessarily made of the purest clay and finest Ceylon graphite, and, as a rule, they lasted only three and a-half to four charges. In addition to this came the high consumption of coke (200 lbs. to each 100 lbs. of charge), the cost of lifting the heavy crucibles (with ¾ cwt. of charge) out of the furnaces by hand, the cost of blast, etc., so that the products had to be sold at high rates in order to cover the expense of production. Moreover, in times of depression, buyers were frightened at the high prices, and looked about them for substitutes for malleable cast steel. Hence, it became necessary to replace the crucible process by something less costly. The open-hearth furnace was practically out of the question, owing to the relatively small quantities to be produced, apart from the high quality desired and the fact that nearly all the castings required were of small size and slender. In this latter respect the small converter would have afforded a remedy, but, on the other hand, would have caused a number of failures in consequence of the inevitable high percentages of phosphorus and sulphur. The daily output (3 to 4 tons) was also too small to allow the converter to be used economically, since the minimum charge that can be properly handled is about 1 ton, and the intervals must not be too long or the converter will have to be heated up again, at considerable trouble and expense. The electric furnace then came under consideration, and eventually the "Stassano" furnace was selected for the work.

At that time, the most successful electric furnaces in operation were those of the "Héroult" type, and the "Kjellin" furnaces, as improved by Röchling-Rodenhauser; and Stassano was not regarded as a serious competitor. Nevertheless, a careful comparison of the three systems demonstrated the necessity for deciding upon the last-named as being the most suitable in the circumstances, without casting any reflection on the capability of the other types for the production of ingot steel. The works and output were small, and in order to reduce the capital outlay it was essential to employ a small furnace, though one in which smallness of dimensions would not excessively lower the useful thermal effect. Simplicity, ease in handling, and supervision were also indispensable features, the furnace having to be operated by the engineers and men already on the staff; and finally the plant must not be so large as to entail the construction of an electric power house, but must be suitable for the supply of polyphase current available from the mains of the Elektrizitätswerk Berggeist, A.G., of Brühl, which serves the whole of the district on both sides of the Rhine.

This condition could not be fulfilled by either the "Héroult" or the "Kjellin" furnace, and it is only lately that a furnace based on the Röchling-Rodenhauser patent has been constructed to operate with polyphase current derived from the user's mains. Even

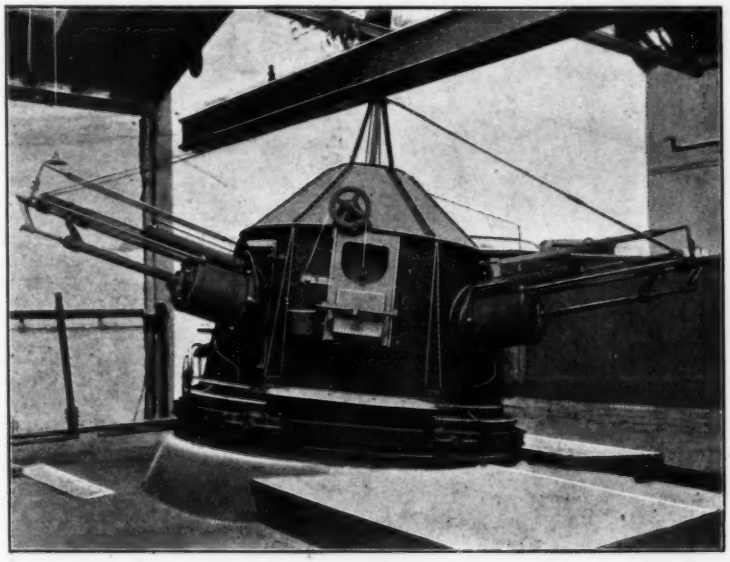


FIG. 1.—THE "STASSANO" ELECTRIC FURNACE AT BONN.

* Professor B. Osann in "Stahl und Eisen."

in comparison with this one, however, the Stassano furnace offers the advantage that the polyphase current can be transformed down from 5,200 volts to 110 volts in a separate chamber, so that a perfectly harmless voltage is present in and near the furnace, and the operation and supervision of the latter are greatly facilitated. In the conditions specified, the cost per kilowatt-hour is only about ½d.

The particulars and calculations were not difficult to assemble, Stassano having at work in Turin an electric steel works with six of his furnaces—two 5-ton furnaces, two taking charges of 1 ton each, and two smaller ones (8-cwt. charges), all of them deriving current from the high-tension town mains and

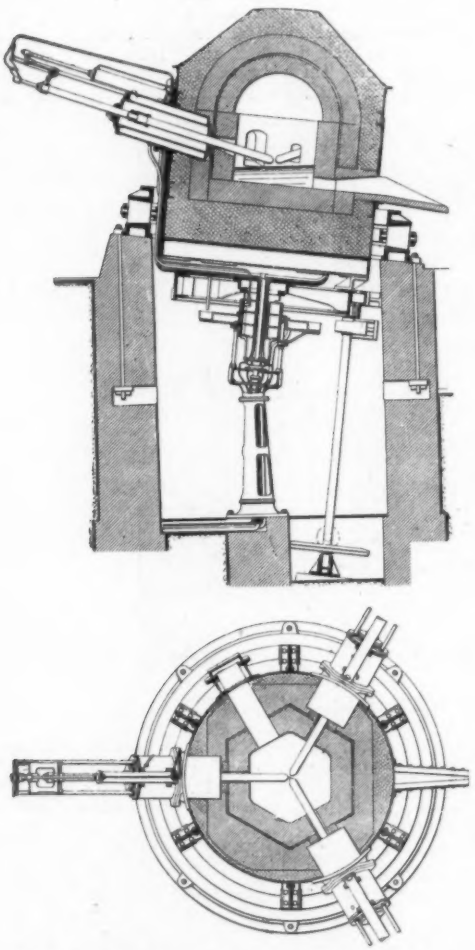


FIG. 2.—SECTIONAL PLAN AND ELEVATION OF "STASSANO" ELECTRIC FURNACE.

operating satisfactorily. The metal of the castings, many of which were intended for the Italian navy, railway and motor car purposes, is excellent; and the report drawn up on visiting the works showed clearly that the quality of metal desired by the Bonn works could be easily obtained. A 1-ton furnace (Fig. 1), or as the maker prefers to style it, a 250-h.p. furnace (the actual consumption per hour averaging 185 kilowatts) was therefore ordered, the work being carried out by Mönkemöller & Company, of Bonn, who acquired the German rights from the inventor.

The Stassano Furnace.

The furnace differs considerably from the older types, which were designed for smelting ore, the arc being formed by means of three carbon electrodes, mounted at equal distances in the periphery of the furnace and heating the charge of metal situated underneath (see Fig. 2). The furnace can be rotated about an inclined axis, the advantages of which will be referred to later. Externally the furnace is enclosed in a strong casing of sheet metal: and it is lined with a tightly rammed stratum of magnesite brick.

It being essential to keep out unnecessary air in order to prevent the metal from becoming cooled and the process retarded, the usual gas outlet at the cupola is suppressed. The electrodes are adjusted by hand, the motive power being supplied by cylinders charged with water from the main, at a pressure of 60 to 75 lbs. per square inch, so that no hydraulic pump or accumulator is needed. Automatic adjusting devices would be very complicated and unadvisable, because the electrodes have to be drawn back when the furnace is being charged, and it may also happen occasionally that one of the electrodes breaks and the broken part has to be removed quickly. This is easily effected at the summons of the man at the switchboard, who watches the three ampère meters and operates the corresponding levers of the hydraulic cylinders controlling the electrodes. The electrodes themselves can be used until the stumps are worn down to a length of 4 in., and can be taken out and replaced in three to five minutes. The carbons are mounted at the tip of a metal tube that slides over a metal spindle and is coupled with the piston rod of the hydraulic cylinder, two sets of metallic packing being arranged between the spindle and the tube. The electric conductor is insulated from the iron plates of the furnace in a very simple manner. The spindle in question is mounted centrally in a water-cooled casing. The movement of rotation is effected in the manner shown in Fig. 2, by intermediate pinion gearing operated by a 5-h.p. electro-motor. When this latter is started, the belt is slipped on to the fast pulley, and a signal bell begins to sound, to warn the men to get back out of the way of the projecting electrode fittings. The furnace turns on a roller-bearing crown. The three current leads terminate in friction contacts, which press against three insulated rings on the vertical shaft and transmit the current to the electrode rods. Owing to this rotary movement about an inclined axis, a single working opening is sufficient, serving as a charging mouth when in its highest position and as a slag tap at the other extreme. Moreover, the arrangement enables the charge to be thoroughly mixed and ensures energetic chemical reaction in presence of a refining, dephosphorising or desulphurising slag. The furnace is well constructed in all its details, and shows that the long experience of its inventor has been turned to good account. Apart from the regular wear and tear of the furnace lining, the apparatus does not seem liable to get out of order in any way, and the high temperature of the steel and slag is indubitable.

Method of Working.

With regard to the method of working and the cost of production, the metal is charged in the solid form, consisting of good, soft scrap, such as trimmings from sections, stamping mill waste, etc. The metal contains 0.2 to 0.5 per cent. (preferably the lower

figure) of carbon, 0.3 to 0.5 per cent. of manganese, 0.07 to 0.09 per cent. of sulphur, 0.08 to 0.12 per cent. of phosphorus, and 0.0 to 0.15 per cent. of silicon. Up to 20 per cent. of turnings are added with the waste heads, etc., from previous operations, making about 50 per cent. The question whether and to what extent molten metal may replace solid in the charge will be discussed later on. The charge takes about 3½ hours to melt, after which a further period of about an hour is necessary to complete the fining, dephosphorising, desulphurising, and deoxidation.

When low-carbon steel is to be produced, attention is directed to obtaining a finished product containing 0.08 to 0.18 per cent. of carbon, 0.4 per cent. of manganese (or a smaller amount of Mn with very little C if for electro-technical purposes), 0.08 to 0.10 per cent. of silicon, 0.06 per cent., at most, of phosphorus, and 0.03 per cent. of sulphur. If specially high quality is desired, the phosphorus content is still further reduced, *e.g.*, down to 0.016 per cent. If milling-tool steel is to be made, the carbon content is raised to the desired level (mostly 0.7 per cent.) by the addition of best Swedish pig shortly before tapping. The charge is 1 ton, and three to four charges can be worked in a day, furnishing 3 to 4 tons of molten steel, the slight loss by oxidation being more than compensated by the gain from the adjuncts and ore. For the basis of the following calculations a daily output of 3½ tons of steel is taken as the average.

In working the charge, two-thirds of the total quantity are put into the furnace (in 15 minutes) the electrodes having first been withdrawn. The latter being now pushed forward again, as uniformly as possible, and the current turned on, the electric arc forms with a downward bend like a garland. Once the arc is established the carbons can be separated to a considerable distance without interrupting it again. The adjusting of the current is completed in a couple of minutes, the strength being maintained at 1,000 to 1,100 ampères, and the volt-meter registering 105 to 110 volts. The hourly consumption of polyphase current is $\sqrt{3} \times 1{,}100 \times 110 = 209{,}330$ volt-ampères, or, during the 4½ hours required for a change, 209,330 $\times$ 4.5 = 941,895 volt-ampères. To express this in terms of kilowatts, it is necessary to insert the factor of conductivity, which is found by observation to be 0.9 to 0.95, so that the amount of electric energy consumed per ton of molten steel is 941,985 $\times$ 0.95 = 895 kilowatts.

This calculation can be easily checked by the kilowatt meter attached to the plant, the readings of which are booked. At one of the smeltings attended by the author, the average consumption of energy was 210 kilowatts, or 909 kilowatt-hours for the 4 hours 20 minutes occupied in the process. In general, the consumption ranges between 800 and 1,000 kilowatt-hours for the ton of molten steel.

A little iron ore or hammer scale and lime is added to the initial charge, in order to refine and dephos-

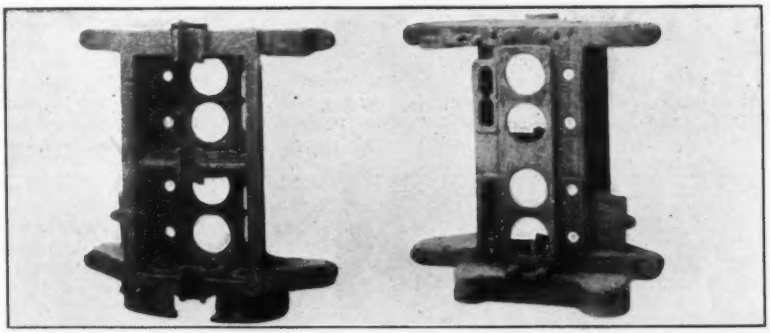


FIG. 3.—MOTOR CAR CRANK CASE.

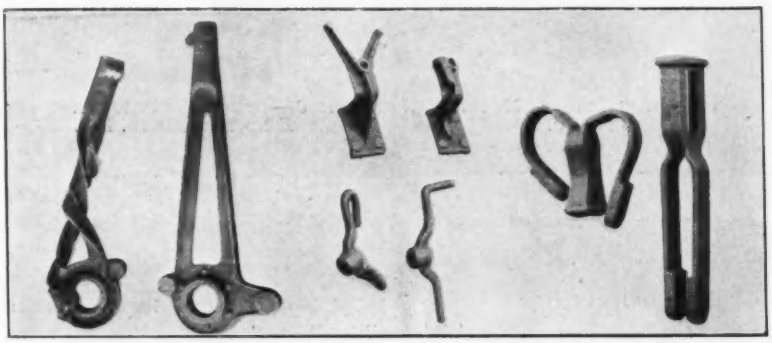


FIG. 4.—MOTOR CAR LEVER, TWISTED COLD.

FIG. 5.—MACHINE PARTS, BENT COLD.

FIG. 6.—PRESS FORK, BENT OUT COLD.

SPECIMENS OF CASTINGS FROM THE "STASSANO" ELECTRIC FURNACE.

phorise it. The first slag is withdrawn before the charge is fully melted, and when this latter stage is reached, the remainder of the charge is introduced as quickly as possible, to prevent loss by cooling, and without turning off the current. When the charge is completely melted the second slag is run off, and, if the condition of the metal requires, more hammer scale and lime are added. The temperature by this time is very high, and the hammer scale produces a considerable disengagement of carbon monoxide in the bath. After the slag has been tapped once more a little lime, with ferro-silicon, is added (but no scale or ore) to form the last slag. In another quarter of an hour the ferro-manganese is added, and the charge is ready for tapping 7 minutes later.

For pouring, the entire contents of the furnace are transferred to a well-heated casting ladle, containing a little aluminium in the bottom. This ladle cannot be used for pouring direct, most of the castings being from 1 to 20 lbs. in weight, and the metal is, therefore, run into warmed crucibles which can be emptied completely and filled again three or four times, old smelting crucibles being used to save the cost of new ones. No better proof of the high temperature of the metal can be given, since otherwise it would quickly encrust the crucibles, more especially as they have to travel some distance.

The life of the electrodes is nine charges, and as each carbon costs 4s. the cost of electrodes per ton of steel is 1s. 4d. Even should a careless workman break a carbon now and again in charging the furnace, the cost will never exceed 2s. 6d., because broken electrodes can always be repaired and used over again.

Cost of Upkeep, etc.

The upkeep of the furnace is costly, but may possibly be cheapened on the lines already indicated. At present the magnesite lining costs about £20 to replace, so that, given a life of three weeks, or thirty-three charges for each lining, the outlay on this head amounts to 6s. 5d. per ton of steel produced, or to 11s. per ton, including wages and sundries. Repairing the lining takes four to six days, during which time the more expensive crucible furnace has to be used. In a works equipped with two or more electric furnaces, this periodic interruption for repairs would not cause any inconvenience; and even in cases where only a single furnace is used, and it should ultimately be found—as is highly improbable—that the life of the furnace lining cannot be prolonged, all that will be necessary to prepare for emergencies will be to lay down a small crucible plant.

Three men are sufficient for each shift, and these will also see to the getting ready of the charge, changing the electrodes, etc. The total wages for day and night shifts will amount to 30s., or 8s. 8d. per ton of steel.

The prime cost of a complete furnace may be estimated at £1,750—including switchboard, foundations, etc.—so that 10 per cent. written off every year for depreciation will work out, on the basis of 3½ tons and 240 working days (840 tons), at 4s. 2d. per ton of steel. To this must be added the royalty.

When the furnace is out of use it must be kept hot by passing current through the electrodes a quarter of an hour at a time, followed by an interval of three-quarters of an hour. The cost of this, allowing for a cessation of work for three hours every night and twenty-four hours on Sundays, comes out at 4s. 6d. per ton of steel.

Cooling water, 440 gallons per hour, costs about 5d. per ton of steel. The cost of forging tools, etc., is included in the general upkeep expenses.

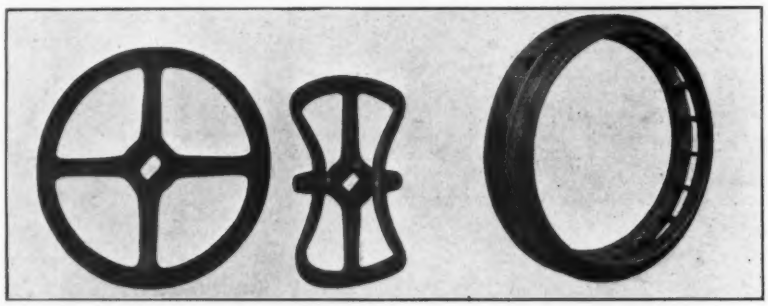


FIG. 7.—HAND WHEEL, 15½ IN. DIA., BENT COLD.

FIG. 8.—DYNAMO VENTILATOR RING, ABOUT 34 IN. DIA.

FIG. 9.—MULTIPLE CRANK SHAFT OF ELECTRO-STEEL, FOR THRESHING MACHINE: LENGTH, 7 FT. 3 IN., DIA., 1¾ IN.

Cost of Producing 1 *Ton of Molten Steel excluding payment of royalty.*

	s.	d.	s.	d.
1. Depreciation of plant			4	2
2. Materials for the charge :—	s.	d.		
1 ton scrap at 67s.	67	0		
44 lbs. hammer scale at 17s.	0	4		
44 lbs. lime at 12s.	0	3		
17½ lbs. ferro-silicon (12 per cent) at 150s.	1	2		
9 lbs. ferro-manganese (80 per cent.) at 220s. ...	0	11		
1½ lbs. aluminium	1	2		
			70	10
3. Cost of current :—				
(a) for working the charge, 900 kilowatt-hours at ¼d.			40	6
(b) for heating up the furnace in the intervals ...			4	6
4. Upkeep of furnace			11	0
5. Wages			8	8
6. Electrodes			2	6
7. Cooling water			0	5
Total			£7	2 7

If work be carried on day and night the item 3 (b) of 4s. 6d. for heating during the intervals of work, will be almost entirely got rid of, and the depreciation and upkeep will also be greatly reduced.

To produce 1 ton of finished castings requires 1.55 ton of molten steel, which, at the above rate, will cost 221s. less 37s. for 0.55 ton of scrap at 67s., or net 184s.

Reducing Working Costs.

The question whether semi-refined iron from the open-hearth furnace or converter can be used to advantage must be answered in the negative, because, whilst the refining is possible in the electric furnace, the quality of metal required is much higher than that furnished by the open-hearth furnace, the quantity being small and more conveniently produced with a cold charge. On the other hand, the transfer of metal from the cupola furnace to the small converter, and thence to the electric furnace, is a very roundabout method, and, indeed, the electric furnace seems well adapted to compete seriously with the small converter where the latter is used, either as an adjunct to, or substitute for, the open-hearth furnace. The electric furnace gives a better quality product, since the phosphorus and sulphur can be controlled, and there is no risk of an accumulation of sulphur, whilst as regards cost, the outlay for charge and fuel for the double working in the cupola furnace and converter (with hematite pig at 85s. to 90s. per ton) is quite as high as for charge and current in the electric furnace.

The items of capital expenditure and wages will be about the same in both cases, but whilst the repairs to furnace lining will be smaller in the converter, there is the cost of blowing to set off against this. The process in the electric furnace is simpler and does not need such strained attention as the refining process in the small converter.

Possibilities of the Furnace.

Another sphere of usefulness remains to be considered, namely, the production of malleable cast iron. At present this is made in four ways—in the cupola furnace, the crucible, the small converter, and the reverberatory furnace. For large quantities the last-named cannot be surpassed, but for small outputs the electric process will beat the crucible process easily.

What will be the result of competition between the electric furnace, the cupola furnace, and the small converter will have to be decided by experiment. If scrap can be used as the charge, and the bath can be carburised with powdered coke during or after melting, it is probable that the electric furnace will come out ahead, the cupola process being far from cheap owing to the high consumption of fuel, great wear and tear, and the necessity for using a special, dear pig-iron. Moreover, the quality of malleable cast iron from the cupola furnace is often defective and unreliable.

Stassano produced excellent mild steel in his furnace, direct from ore, and obtained clean, thin-walled castings, thus proving that large quantities of slag are not incompatible with a hot bath. It is, therefore, evident that a trial could be carried out without any great difficulty or expense in the case of works possessing an open-hearth furnace or converter.

Mr. R. Buchanan and the Society of Arts Medal.

As stated in our issue of July last, Mr. Robert Buchanan, who is well known in British foundry and scientific circles, has been presented with a massive silver medal by the Royal Society of Arts for the best scientific paper of the year. The illustration herewith shows the medal, the rim of which contains the explanatory line:—"Robert Buchanan, for his paper on 'The Application of Science to Foundry Work, 154th Session, 1907-8.'" The paper, it will be remembered, was read by Mr. Buchanan before the Society in London in February, 1908. The presentation by a Society which stands high among British organisations is an exceptional honour conferred for the first time upon a British foundryman.

Mr. Buchanan at present holds the position of Director to Chamberlin Hill, Limited, Walsall and Lichfield, but to foundrymen generally he is best known as the first President of the British Foundrymen's Association. For some years he has been President of the Birmingham Branch, a position he still holds. He combines in a remarkable degree scientific knowledge and practical experience, and among other papers contributed to the Foundrymen's Association, in addition to the one which earned for him the compliment of the Society of Arts, are: "Mixing and Melting of Foundry Irons," and "The False Witness of the Test Bar."

Repetition Work in Small and Large Quantities.

By G. Buchanan, Wrexham.

British Foundrymen's Association: Lancashire Branch.

At the November monthly meeting of the Lancashire Branch of this Association, held at Manchester, the chair was occupied by Mr. R. H. Sherburn, and a paper was read by Mr. G. Buchanan (of Wrexham), on "Repetition Work in Small and Medium Quantities." The paper proved of practical interest to the members and evoked considerable discussion. The experiences of various members in the rapid execution of orders for small castings were freely given and discussed, and a number of questions were answered by Mr. Buchanan. During the reading of the paper, which was as follows, lantern slides and models were shown to illustrate the various points brought out.

Repetition Work.

It is a strange fact that many engaged in the foundry business have very vague ideas about repetition work, they never having been brought into actual contact with this particular branch of the business, where, for example, tooth wheels are placed in machines direct from the moulding shop without any filing or fitting; where parts are fitted together with little or no skill by boys, and in some cases holes are cast in parts leaving screw threads, which compare favourably with drilled and tapped holes. These are a few only of the features of some particular lines in which repetition plays a prominent part, and in which repetition spells quality, quantity, and cheapness in production.

The making of a number of moulds from the same pattern is the first glimpse we get of the cheapening effect of repetition, as it is obvious that if a dozen moulds are made from the same pattern the last moulds will be made in considerably less time than the first, and, generally speaking, the last casting will be better in quality than the first.

The fact about the cheapening effect of repetition applies in a greater or less extent to all classes of castings. The skill of the moulder, however, in cheapening production is only one of the factors with which we are provided, for it is here that the mechanical ingenuity of the foundryman has full opportunity for expansion, and it is now a fact that up to a certain point the number of castings that can be produced in any one day, from one pattern, is only limited by the amount of money which it is advisable to expend in the necessary tools and plant; also that the increase in the output is followed by a corresponding decrease in the price of each casting made.

Most founders have need of a method which will be beneficial in dealing with small and medium orders consisting of, say, 50 to 500, or more, of the same piece, which cannot in the ordinary way of working be made at a profit, and which cannot be mounted on the moulding machine profitably on account of the few castings required, the expense which would have to be incurred, and also the delay which these preparations entail, which would in many instances delay the shipment of complete orders or sets of parts.

Brassfounders have need of some method of dealing with small orders when steps, bearings and a thousand other small parts are being made in fair quantities from customers' patterns. These parts are usually made from odd sides or plaster turn-over boards. Shops making machines having runs requiring thousands of parts will find the method about to be described a useful one for dealing with the new machines which are being constantly brought out, and also in dealing with special sizes of machines for which there is not much demand, but which have to be made.

Method of Dealing with Small Orders.

Before describing this method, it is understood that no attempt is made to compare it with some moulding machine processes, where special castings are being made at a very rapid rate, and in which the large expense incurred is justified by the enormous output; also the method is not claimed to be original, but rather a combination of some of the features employed on moulding-machine work, and also in plate and bench working.

The method consists briefly of a match plate process; that is, two mould faces are prepared and handled just the same as in plate-moulding. The apparatus is two pattern-frame carriers, and a plentiful supply of duplicate moulding boxes. The size of the moulding box is not important, except when the process is used for bench moulding. I have found a 16-in. by 12-in. box a convenient size to handle.

The frame carriers are 1 in. deep, and are V-shaped on the inside edges; they are split across the corners and are fastened by two set screws. To make a pair of mould faces the patterns or group of patterns are carefully moulded in one of the boxes to be used. The jointing of the mould is made exactly as it should be, and to ensure this the patterns should be lifted out of the mould after the joint is made, in order to discover any possible error in the parting line. The top part, having been rammed up and lifted off, is placed on its back level, and the carrier-frames placed one on each half of the mould. The frames are, of course, drilled and pinned in duplicate.

The pattern or patterns, having been drilled and tapped for a small bolt which projects into the carrier frame, a little oil is smeared over the face of the mould, and also on the inside edges of the pattern-frame carrier to prevent the plaster (for which it is now ready) from sticking to the frame. A few ¼-in. wires are jammed into the V's of the frame to strengthen the plaster, which is only 1 in. thick, and the plaster is also made harder by a slight addition of alum to the water when mixing. The plaster is then poured into the moulds formed by the sand impression and the plaster frame carriers. Ten minutes after pouring the plaster the frames are taken and washed under the tap and set to dry for a few hours; usually the frames are filled at night and are ready for trimming and varnishing on the following morning. They are then ready for moulding from.

When pouring the plaster it is sometimes necessary to pour a little white metal into small projections, such as lugs, etc., which would soon wear if cast in plaster. These small projections are just filled with white metal, and a small nail is placed in at the same time, the nail holding the metal in place in the plaster afterwards.

The fixing of the patterns in the moulding box is varied to suit different classes of patterns. Gener-

ally speaking, the body of the pattern comes in the bottom half of the mould, and when this is so the match-frame for the drag part has the pattern attached to it by means of screws already mentioned, while the top part frame is formed entirely of plaster.

In the case of split patterns half of each pattern is attached to each pattern-carrier. Patterns having irregular parting lines are readily made; in fact, they present no difficulties. Deep pockets are protected by extra wires in the carrier frames to strengthen the plaster. Wood patterns are sometimes used, but usually metal patterns. When wood patterns are used, the patterns are taken from the plaster as soon as it sets and returned when the plaster is dry, the patterns being fastened by means of wood screws from the back of the carrier frame through the plaster. The class of patterns which can be used is fairly large; in fact, any patterns which can be fixed on a plate are suitable for this process. It is not recommended for spur wheels or other work of that kind, which is best done on the stripping-plate machine.

The pair of prepared carrier-frames are used as ordinary plates, or the carrier for the drag part is mounted on a turn-over machine. Deep patterns can then be moulded without much rapping of the carrier-frame, which would soon destroy the plaster. With ordinary care, however, fairly large numbers of moulds are made before the plaster is broken, and when this takes place it is no big matter to make fresh plaster.

Time Taken to Prepare a Pair of Pattern Frames.

The average time taken to prepare a new pattern, or set of patterns, and run in the plaster is about two hours; sometimes in the case of nearly flat backs it is less, while in other cases, where there is a lot of detail, extra time is necessary. The plan followed is to have the same moulder making the moulds and the pattern frames. When a fresh pair are wanted the moulder starts after his day's work is done, say, about 4 p.m., and works on until he has finished and placed the plasters in the stove, somewhere where they will receive a gentle heat. In the morning he spends a few minutes in trimming the gates, etc., when the plaster receives a coat of shellac varnish which dries in a few minutes. It is then ready for the moulder.

Speed at which Moulds are made Compared with Hand Moulding.

The average output in moulds from patterns mounted as described is about 4 to 1; that is to say, a moulder will place four times as many moulds on the floor made from the frames as he would when moulding from loose patterns using the same boxes. The moulds made from the frames will usually contain more castings when groups of patterns are used than would be found convenient to work in ordinary bench moulding. Five or six changes are sometimes made in a day, when a few castings are wanted in a hurry, about five minutes being sufficient time to take out a pair of plasters and replace them by another pair. About 100 pairs of plasters have been made during the past three years, and allowing for plasters which are broken up when the orders are complete, on an average one set is made per week.

The value of the plant tied up in accumulated plasters is very trifling, consisting as it does of slabs of plaster with no other item in the shape of plates or expensive tooled work. The patterns, if not required to be returned to customers, are left in the plaster, so that repeat orders are easily executed. Plasters that have been made about three years have been recently used and are very little the worse for wear. Of course, they have not been in use all the time, but a few hundred moulds have been made from them about twice a year. Only one pair of frames are used, and these are provided with flats in the V parts; these flats are in different positions in each frame, so that when returning a plaster to the frame no trouble is experienced locating it in its right place or its right frame.

Experience of the Method.

I do not think I can say much more about this method except that it has proved itself extremely useful in my own particular case, where it has filled a gap in which ordinary plate-moulding proved to be quite useless on account of the expense of making the plates and the expensive fitting up required, and also the delay which would naturally take place before castings were produced.

An example of the usefulness of this method happened recently. An order was received for 50 pairs of block pedestals, which filled the boxes used with the frames. These patterns were received in the afternoon and the order was easily completed the next day, the 50 pairs of pedestals being moulded in about seven hours. When made by hand the daily output was ten moulds. After allowing for the time spent in running the plaster, and the cost of the plaster, the saving effected on this little order works out to about 10s.

Snap flasks are used with success when quantities of duplicate boxes are not at hand, and with the aid of binders or curbs fairly heavy castings are produced. Where snap flasks are used bottom boards or plates should always be used, the absence of these latter being the cause, I believe, of many failures in this particular line. However, personally, I prefer and use wherever possible, a rather light pattern moulding box having sides bellied or V-shaped. This adds to the strength of the box, and a mould need not then be rammed as hard as a brick to guard against "drop outs."

Finally, the three points which are noteworthy in connection with this method are:—(1) The quick way in which patterns are prepared for moulding; (2) the large increase in production, averaging about 4 to 1; (3) the inexpensiveness of the apparatus and accumulated plasters.

Mr. J. Orten-Boving has ceased to act as sole British agent for Messrs. Escher, Wyss & Company, of Zurich.

Mr. S. Hardman, of 3, Queen's Terrace, Jesmond, Newcastle-on-Tyne, has been appointed North of England representative for the Falkirk Iron Company. He previously represented the Carron Company in the same district.

Messrs. T. Green & Company, Caseley Foundry, near Bilston, have appointed Mr. C. H. Tilsley, of Bristol, as their Welsh representative in place of the late Mr. F. G. Kitley.

The Tenter Foundry Company notify us that they have started business at 82, Tenter Street, Sheffield, with offices at 15, North Church Street, Sheffield, as makers of all kinds of malleable iron castings for shipbuilders, engineers, etc.

Alloys in Iron, Steel and Brass Foundries.

British Foundrymen's Association: Sheffield Branch.

At the second general meeting of the British Foundrymen's Association, Sheffield and District Branch, held in the Department of Applied Science of the Sheffield University, on November 21, the President (Mr. H. Pilkington) in the chair, Mr. Percy Longmuir read a paper, in the course of which he dealt with alloys produced in iron, steel and brass foundries. He remarked that the purport of alloying was exemplified by reference to changes in electrical, chemical and mechanical properties. In the case of electrical properties, a series of nickel iron alloys were quoted, showing the increase in resistivity following an increasing content of nickel. Chemical properties were illustrated by reference to the effect of lead and antimony in the production of acid-resisting alloys. Mechanical properties were illustrated by reference to ordinary and special steel castings. The commercially pure metals—iron, nickel, aluminium, copper, tin, lead, and zinc—were dealt with, and their limited commercial application indicated so far as foundry work is concerned. The metals when alloyed offer wide field to the founder. The speaker illustrated this by reference to copper-zinc alloys, showing the effect on mechanical properties by gradually increasing contents of zinc. Taking 60 copper and 40 zinc alloy as a base, the influence of a third element was considered. The effect of small additions of iron, tin, aluminium, and manganese on mechanical properties was shown by reference to typical tests. On the whole the effect of these additions is to raise the maximum stress and elongation. After reference to special high-tension brasses, the copper-tin-zinc alloys, or gun-metals, were considered. The stiffening and hardening effect of tin on copper was shown by tensile tests. Phosphor bronzes were discussed, and the range in mechanical properties shown by typical tests.

Pyrometers and Temperature Measurement.

British Foundrymen's Association: Lancashire Branch.

At the monthly meeting of the Lancashire Branch of the British Foundrymen's Association, held in the School of Technology, Manchester, on Saturday, December 5, Mr. R. W. Kenyon presiding, Mr. E. L. Rhead (Lecturer in Metallurgy, Manchester School of Technology), gave a lecture on "Pyrometers and Temperature Measurements." In his opening remarks he showed that the temperature at which many metallurgical operations were carried on had a great influence on the qualities of the finished materials. It was, therefore, necessary that we should be able to register high temperatures with a much greater degree of accuracy than was possible by sight only, and while there were many instruments of elaborate construction designed for the measurement of high temperatures, he proposed to describe some of the instruments which, being of fairly simple and strong construction, would be of practical service in the foundry.

The "Bristol" recording pyrometer was the first instrument to be explained, the lecturer showing its construction and describing the laws upon which its action was based. Siemens' specific heat pyrometer then came under notice, and it was pointed out that although one of the earliest types, this instrument was still largely used in connection with annealing furnace, hot blast, and armour-plate work, owing to its convenience and ease of manipulation. Mr. Rhead then passed on to the more delicate instruments of the electrical resistance type, the Siemens' instrument being fully explained and shown round. The "Whipple" indicator, used in conjunction with Siemens' electrical pyrometer, for the measurement of the electrical current set up when the pyrometer same in contact with the heated furnace, was also described. The accuracy, portability, and simple manipulation were strong points in favour of these instruments.

Attention was also drawn to the thermo-couple type of pyrometer, the physical action of which was made quite clear. The "Roberts-Austen" instrument called for attention, the lecturer, by means of sketches, showing the construction very clearly, and indicating the means by which a continuous record could be made.

The "Fery" pyrometer then came under consideration, and the fact that the instrument required no connection with the object of which the temperature was desired, attracted much attention. Mesure and Nouel's instrument, which is a combination of "Nicol" prisms and a quartz plate, was also explained, it being shown that the desired accuracy was not so likely to be obtained owing to the great personal element entering into its use.

Methods of determining high temperatures without the initial expense of scientific instruments were also shown by the use of "Seger" cones, Watkin's heat recorder, Wiborgh's thermophone, and others. The lecture was illustrated by lantern slides, diagrams, etc., and the various instruments were also exhibited. Following the lecture the meeting adjourned to the metallurgical laboratory, where a demonstration of the working of the "Roberts-Austen" and the "Fery" pyrometers was given.

Factors in Coal Consumption.

British Foundrymen's Association: Birmingham Branch.

At a meeting of this Branch of the Association, held on Saturday, December 12, the above question was discussed. The President of the Branch, Mr. Robert Buchanan, was in the chair.

Prefacing the discussion, the PRESIDENT said that they were making somewhat of a departure from their usual course of procedure. There was to be no set paper, but they were trusting to the members to tell what they knew with regard to coke and its use. In order to commence the discussion Mr. Hiorns would give them a short general lecture upon how coke was made in the various ovens.

MR. A. H. HIORNS said that he would deal first of all with the most ancient method, that of making the coke in ordinary piles or heaps. The selection of coal was of the first importance, because certain kinds of coal would not produce adherent coke at all, but only powder, while others would give a coke so soft and friable as to be useless for furnace purposes. Dealing with the most ancient method, Mr. Hiorns said that the coal was, first of all, crushed to a small state of division—this was the case in all the methods—in order to produce the state of conglomeration which they saw in ordinary coke. The ground must be well prepared to drain off the moisture. The coal was piled up and covered with wet slack, so as to exclude the air from the surface of the pile, then by means of a base and a central opening flues were formed. The usual practice was to continue the coking of the pile for about six days. A more economical method, because by it the heat was better utilised, was by means of kilns having vertical flues and also horizontal flues in the walls, the draught of which could be regulated by means of loose bricks. The walls were built with the flues in them, the kilns were filled in with coke in layers and with wet slack, and stamped down. The stakes of bases of wood which were first put in were then withdrawn, and the space which they had occupied formed the flues, so that the draught might pass right through the mass of coke. One of the old forms of kiln was known as the beehive oven, and there was a modification of it about which he would not trouble them. In this oven they had a beehive built of brick with two holes in it; that is to say, the front was open, and there was an opening at the back for the escape of the gases which were driven off by the heat. In an oven of this sort they got excellent coke. The patent furnace gave no better result as regards the quality of the coke than did the older ovens; in fact, he believed most people preferred ordinary beehive or kiln coke, or even pile coke, to what was known as patent coke. The patent ovens were more complicated, and more expensive to build, and yielded a much larger quantity of coke in a less time than did the old kilns, but, though economical in this respect, they did not produce, as a rule, such a good quality of coke. As they knew, coal consisted of carbon, hydrogen, nitrogen, and oxygen. Different modes of coking produced different results in regard to the waste of gas and coke. In the old mode the gas burned and was wasted, and passed out of the chimney. Then, again, if they had the gas burning in contact with the coal some of the coal was burnt and the coke production was reduced. The carbon of coal consisted of what they called fixed carbon; that is to say, carbon which would not burn off if the furnace was properly constructed, and a volatile carbon which passed off as gas. The coke consisted of this fixed carbon, and the more of this carbon they burned off in contact with the oxygen and hydrogen, the less coke they got. Therefore, at an early stage of the coke industry attempts were made to construct furnaces of such a nature that the gases would not burn in contact with the coal. Take Appolt's oven as an example of one of the earlier forms of improved coking apparatus; the gases were made to pass off into outer flues and were burnt there without any contact with the coke, while the heat was utilised to assist in the coking. Coppée's oven was another form of external combustion oven. In this oven the heat from the burning gases was conducted by the flues, so as to assist in maintaining the bottom heat, afterwards returning into the vertical flue. The even distribution of heat was an important matter, especially in the making of wood coke, because it was most desirable that the material under treatment should be kept under uniform conditions throughout the mass, and throughout the process. In the ovens known as the Carvé and the Simon-Carvé, the gases were more perfectly utilised. The gases were burned outside the oven. In the earlier types of oven there was no attempt to get anything from the coal but good coke. Coal, as they knew, would produce three things of commercial value—coke, gas, and tar. They could so operate in the oven as to get good coke, but bad gas and bad tar. That is to say, if they wanted to produce good coke they would not produce a good lighting or heating gas. The object of the latest kinds of patent oven was to get these three substances all in as perfect a form as possible. Carvé tried to get two of them—a valuable tar and a valuable coke. One feature of this furnace was the hollow walls, having a number of serpentine flues passing through them, and thus the walls could be got very much hotter by the burning of the gases inside these flues, and the heat could be better communicated to the coal inside. By means of condensers Carvé recovered the tar, and this was the case with some other types of ovens. In the Semet-Solvay and Otto Hoffman ovens, likewise, it was claimed that they got first-class tar and first-class coke.

As to the properties of coke, the speaker said he might perhaps differ from some of those present, as each would have his preference, owing to the class of work he had to do and the conditions under which it was done. He would, however, give them his own ideal. Coke varied in physical and chemical properties, according to the mode of coking and the quality of the coal employed. The best coke was hard and compact, clean, sonorous, and of dark silver-grey lustre. It should be free from moisture and volatile hydro-carbons. Soft coke was liable to crumble and to interfere with the draught. Soft and porous coke was liable to be attacked by carbon-dioxide, forming carbon monoxide, and thus wasting the carbon of the fuel. Good coke contained 90 per cent. of fixed carbon, and should be low in sulphur and ash. The ash was not only useless, but required flux, and increased the slag and absorbed heat. Much sulphur made the iron white and required limestone as a flux to remove it. The sulphur should not exceed 1 per cent., and the ash should be under 10 per cent. Gas coke was soft and pliable, and contained 1½ per cent. to 2 per cent. of sulphur (which was objectionable) and upwards of 10 per cent. of ash. Hard Durham coke was considered the best, and the next best, perhaps, was that of South Wales. Mr. Hiorns gave the fol-

lowing analyses of coke as showing the properties which he considered differentiated between good and poor coke:—

Analyses of Coke.

	Good.	Medium.	Poor.
Carbon	92.6	89.0	81.0
Ash	6.0	9.0	16.0
Sulphur	0.7	1.3	1.5
Volatile matter ...	0.4	0.5	1.0
Moisture	0.2	0.2	0.2

For cupola work, the speaker said, a somewhat lighter and more porous coke was more necessary than for blast furnace work, as strength was not so important. But the denser the coke the lower the fuel consumption. The beehive oven was said to yield denser coke than that made in patent ovens. Coke contained fixed carbon, a little oxygen and hydrogen, all the ash, and the greater part of the sulphur of the coal from which it was produced.

Mr. R. Mason said that the point he wished to emphasise in relation to coke consumption was the amount of air required. He was of opinion that in the majority of cupolas too much air was blown in for economical melting. He was well aware that the customary complaint when there was anything wrong was that there was not enough blast, but he also knew that the complaint was made without any knowledge of the amount that was being blown in or of the amount required to be blown in. In comparisons with regard to coke consumption and the blowing in of air, he held that the cupola diameter should be measured inside the brickwork at the bosh. This measurement determined the rate of melting per hour when the blast pressure was between 12 and 20 ozs. per square inch, and it was a grave mistake to blow more air in than 30,000 cubic feet per ton melted. He believed 28,000 cubic feet per ton was quite sufficient. The following table showed the average rate at which cupolas of the respective diameters given would melt when melting continuously for three or more hours:—

Inches diameter.	Per hour. Tons	cwts.
20	1	5
24	1	17
30	3	0
36	4	5
43	6	1
48	7	10
54	9	1
60	11	15
62	12	11
66	14	15

These figures, Mr. Mason explained, he had compiled from his own experience, and that of furnaces used by a number of friends. He believed that 28,000 cubic feet was quite sufficient for a ton, but, of course, it depended upon the weight of iron in each charge, together with the coke used. If they had a large amount of coke then they would require a large amount of air to burn it; and, similarly, if they blew in more air than was necessary they would require to charge more coke than should be necessary to make their iron hot enough for their use. This was because of the cooling action of the blast and its travelling through the cupola too quickly. When he said 28,000 cubic feet of air per ton of iron melted, he was thinking of the conditions in the cupola of which he at present had charge, when (apart from the bed) 154 lbs. of coke of 91 per cent. carbon were charged per ton of iron. If it was desired to calculate the amount of air, the calculations must be based on the amount of carbon in the charge of coke, and if more carbon were used on account of the iron requiring more heat to make it of the necessary fluidity, then more air would be required per ton of iron. If, however, no notice were taken of the amount of air being blown in, but more coke were used until the iron became hot enough for the purpose, then most likely coke would have to be put on to overcome the excess of air being blown in. He advised them to consult the table he had given of inside diameters with the rate of melting that diameter was capable of, and to regulate their air as between 28,000 and 30,000 cubic feet per ton. He was sorry that his table did not agree with any tables which he had previously seen, but he imagined that to be due to measuring at different places in the cupola, a large number being measured at the tuyeres and not at the bosh, which latter, he contended, was the only right place to measure for this purpose. A rough way of calculating when using a positive blower was to take the maker's figures given in feet per revolution and multiply it by the revolutions. With a fan, of course, this could not be done. The proper way would be to measure the rate of travel of the air in the blast pipe together with the area of the pipe and the pressure. A great deal of faith was pinned to the tale which the pressure gauge was supposed to tell, and he wished to emphasise the fact that the pressure gauge did not tell how much air was blown in. Moreover, if they were getting 12 ozs. pressure, they were not necessarily doing the same as a cupola in another works at that pressure. The pressure gauge was not altogether worthless, but it was worthless as an indication of conditions governing the working of different cupolas in works charged under different methods. Take a cupola of 60 in. diameter at the bosh, with a height of 12 ft. between the charging door and the top tuyeres, charged in charges of 1 ton of iron a time, with small scrap, coke, and limestone to suit, and kept full up all the time of charging for three hours or more at a time; how could that be compared with the blast pressure of a similar cupola which was filled up and melted for one hour only on large scrap, and with 2 or 3 tons of iron on each charge, with coke and limestone to suit? Or, how could it be compared with a cupola of 30-in. bosh diameter, and only about 8 ft. or 6 ft. between charging doors and tuyeres, and where the cupola man had to attend to the charging and come down to tap out as well? A friend of his had shown him some castings in which there were certain defects, and it struck him (Mr. Mason) from the analysis that too much air had been used, so that the carbon in the iron had been burnt up. He advised that the air should be cut down, and the result was his friend was not only able to melt much faster, but also got rid of the cause of complaint in the castings. In this way, by cutting down the air, he was able to save about £100 in a year.

Mr. George Hailstone maintained that all coke coming into the foundry should be analysed. He wished to say a few words upon the selection of coke by means of its chemical analysis. He considered that foundry coke should be bought to the following specification:—Ash should not exceed 8 per cent.; sulphur should not exceed 0.75 per cent.; fixed carbon should never be less than 88 per cent.

The following table showed the analyses of a number of cokes supplied for foundry use:—

No.	Brand of Coke.	Constituents per cent. Ash.	Sulphur.	Volatile matter.	Fixed carbon.
1	Sample of coke submitted by Agent.	17.680	2.648	1.622	78.050
2	" "	15.000	0.603	0.560	83.837
3	Weardale	8.930	0.887	2.035	88.168
4	Penygraig	9.570	0.665	—	89.765
5	Platts	8.480	0.755	1.875	88.890
6	Liversedge	10.766	0.531	0.175	88.534
7	Waldridge	9.490	0.625	1.174	88.711
8	Blaina	5.790	0.834	0.325	93.054
9	Consett	7.300	1.064	1.021	90.615
10	Pease's French Durham	7.390	0.738	0.628	91.244
11	Altham	8.000	0.518	0.256	91.226
12	Habergham	6.530	0.584	0.321	91.565
13	Ffaldau	5.700	0.618	0.458	93.164
14	Pitch	1.109	0.548	1.249	97.094

The cokes Nos. 1 and 2 were samples submitted by agents as foundry furnace coke. According to his own specification, No. 1 coke was condemned by being exceedingly high in sulphur and ash and low in fixed carbon, and No. 2 coke by being high in ash and low in fixed carbon. These two cokes were entirely unsuitable for the cupola. Coke No. 3 he considered to be too high in ash and sulphur; Nos. 4, 5, and 6 were high in ash; Nos. 8 and 9 were high in sulphur; Nos. 10, 11, 12, 13, and 14 came within the limits of his specification. Of course, he did not want them to suppose that the cokes that were outside the range of his specification were unsuitable for cupola work, because they no doubt possessed certain characteristics that especially adapted them for certain purposes. Also, it should be remembered, the analyses were only true of the particular consignments from which the samples were taken. Coke, being only a partly manufactured material, was very liable to great variation in the percentage of its constituents from week to week. He might say that the only coke he had ever come across with a consistently low sulphur was Altham coke, which very seldom had above 0.5 per cent. The coke made from pitch, No. 14, containing only 1.109 per cent. of ash, was very useful in cupola practice for certain purposes. In conclusion, he might say that in his own practice he had always obtained the best results with cokes the analyses of which came within the range of his specification.

Mr. Sadler (Wolverhampton) said it seemed to him that one of the most useful things the Society could do would be, if it were possible, to appoint a committee which should collect information and standardise cupola working. Some years ago the South Staffordshire Institute of Mining Engineers dealt with the working of boilers in this way, with most satisfactory results.

Mr. Shaw did not think they could get any formula that would satisfy the majority of founders while working conditions were so varied. The coke consumption at his foundry was 101.79 tons per month, which they would admit was exceptionally low. They produced pipes, and used a fairly high phosphoric iron under favourable conditions. In another department the consumption exceeded 200 tons. He considered the standardisation of cupola practice out of the question as far as coke consumption was concerned. For a small cast their tuyeres would be small and the consumption of coke less, but with a large cast they must have their tuyere area very much higher and a larger consumption of coke. They often blamed the iron for the sulphur it contained when frequently they got the high sulphur in the fuel.

Mr. Poole thought it ought to be possible to fix some definite standard. Given a definite size of cupola it ought to be possible to do a definite amount of work in it with a certain charge and a certain quantity of coke in a given time.

Mr. Pemberton said that he was using a cupola 40 in. in diameter, with five tuyeres in the bottom row and three in the top, giving a tuyere area of 52.8 in., and a depth of the coupla of 16 ft. 10 in. to the charging door. From the bottom of the tuyeres to the bed was 21 in. When using a blast pressure of 18 in. of water their coke ratio was 15.4 tons of iron to 1 ton of coke. With regard to fuel economy, it was important to watch the amount of ash in the coke and to get the correct amount of limestone flux. If they got too much limestone they also got a spongy slag, which was detrimental. The black centre which formed in front of the tuyeres should be immediately knocked away, otherwise they would not be getting the right amount of blast in the cupola.

The Chairman said that he had received the following letter from Mr. F. J. Cook (President of the National Association):—"I send three samples of coke—one good and two bad. The points I should lay stress upon if I were able to be present are:—We buy by weight and use by volume; it is therefore essential that the coke should be as light as is compatible with the carrying a good burden. I consider that the carbon should never be below 90 per cent. Most of the good cokes I know of contain 92 to 93 per cent. Sulphur, for obvious reasons, should be as low as possible, 0.6 per cent. being as low as is practicable, but it should seldom reach 0.8 per cent. A hard coke that will carry a good burden necessarily contains a fair amount of ash; a reasonable amount is from 6 to 8 per cent. For most classes of castings, especially when they have to be machined, it is imperative that the metal should be melted very hot; it is, therefore, misapplied economy to skimp the coke and have a resultant high percentage of scrap castings. On the other hand, it is wrong to use too much coke."

Mr. Buchanan, referring to Mr. Mason's remarks, said that they were getting away from the idea which was so prevalent a few years ago that the more air supplied to the cupola the better the result. The discussion showed the great necessity of a clear knowledge of the amount of air blown into the cupolas. Probably 90 out of 100 foundrymen had not the least idea of this, and until they had these clear ideas cupola practice would never be what it ought to be. Blast gauges were of use up to a certain point, indicating, for instance, when the cupola was bunging up, but that the gauge would do much more than that he would not say. It gave some idea of pressures, and this was better than no idea whatever, but it was very confusing to hear the gauge described in so many ways. One spoke of so many inches of water gauge, another of so many ounces of pressure, another of such and such a height of mercury. A table reducing all these modes of measurements to one value would be of considerable use. With regard to the standardisation of cupolas, there was a book by Thoms D. West, at the end of which certain statistics gathered from various parts of the United States were given which were very curious reading. He did not know whether Mr. Sadler, when he spoke of standardisation, realised what an exceedingly large order he wished the Association to undertake. In regard to the charging of the furnace they must make some allowance for the moisture. However, a large amount of moisture was lost during the weighing, so that he did not see how the moisture was going to do much harm. In melting 15 tons of iron with one ton of coke, Mr. Pemberton had made a record for anyone in that room so far as he (Mr. Buchanan) was aware. He believed that Mr. Pemberton moulded for railway tyres, and in so doing melted in very great quantities. His iron contained a large amount of phosphorus, and thus it did not require very great heat, while the cupolas were situated within a short distance of each other. Consequently it was possible to melt the metals with a very small amount of coke. A man who made a great many wasters while casting for the sake of experiment should not be grumbled at but rather encouraged, but to spoil castings for the sake of coke economy was bad policy.

The falling off in the profit of Fraser & Chalmers, Limited, for the last year, is due to extra expenses which have been involved by the establishment of new lines of manufacture at Erith. At Erith the new turbine shop has been completed, and was equipped and put into operation early in 1908. The total cost of this important addition to the works was about £60,000 up to June 30. The manufacture of conveying machinery has received close attention during the year, and has necessitated increased expense for extra staff and accommodation.

Notes on Phosphor Bronze.*

By A. Philip, B.Sc., Assoc. R.S.M. (Admiralty Chemist).

Muntz metal is a copper zinc alloy of very delicate chemical composition, and possesses remarkable mechanical properties which have been well known in practice for many years. Phosphor bronze is a more complicated material than Muntz metal, and on this account it is all the more important that compositions of a suitable chemical character shall be selected for carrying out an investigation of its mechanical and microscopic character, as modified by heat and work.

With phosphor bronze the range of compositions from which a selection can be made is in practice somewhat great, and is not, as in the case with Muntz metal, restricted within very narrow limits. On this account it appears to the writer that the first steps towards the selection of a suitable phosphor bronze composition upon which further investigation as to the effects of heat and work treatment can be carried out, must consist in the consideration of as large a number as possible of mechanical tests made upon phosphor bronze alloys of different known chemical compositions.

The object of the present notes is two-fold: First, to put on record connected results of the chemical and mechanical tests of a considerable number of samples of phosphor bronze with the view of arriving at some general provisional conclusion as to the most reasonable chemical specification for this material; and, second, to enable, by means of these results, a selection to be made of one or more compositions upon which further exhaustive investigations may be carried out as to the connection between mechanical properties and heat and work treatment.

The results of the chemical analyses and mechanical tests tabulated here have been obtained during the past two or three years in the course of the routine survey of Government supplies for the Navy, and permission for their publication has been granted by the courtesy of the Board of Admiralty. The chemical tests were carried out at Portsmouth Dockyard, and the results of the mechanical tests have been supplied to the writer by many of the Admiralty overseers, under whose supervision they have been made, and for whose kind assistance the writer wishes to take this opportunity of recording his very cordial thanks.

All the samples, the results of whose tests are here given, are castings. The samples may be approximately divided into five groups, namely:—

(*a*) Drawn rolled or forged phosphor bronze, such as rods, rolled plates and sheets, rivets, wire, etc. These all contain at least 94 parts per cent. of copper, with phosphorus varying from 0.11 up to 0.4 parts per cent., the remainder being tin. The ultimate tensile of these samples is never lower than 19.7. [These samples are not included in the Table I.—Ed. F.T.J.]

(*b*) *Small Castings.*—These are described as castings only, and were so described on receipt for test at Portsmouth. In general, the ultimate tensile stress at which these samples broke was low, varying from 13 to as high as nearly 18 tons per square inch, whilst the copper varied from 82.3 to 90 per cent., and the phosphorus from 0.3 to 0.71 per cent. Owing to the difficulty of making mechanical tests on small samples and the usually unavoidable rapidity in cooling, somewhat low results are to be expected in material of this character.

(*c*) *Bearings.*—These contain from 84.5 to 91.0 per cent. of copper and 0.37 to 0.85 per cent. of phosphorus. The ultimate tensile stress varies from 7.76 up to 26.4 tons per square inch, and eight out of the ten samples have an ultimate tensile of over 18.8 tons.

(*d*) *Sheaves for Blocks.*—The composition of the 25 samples is—copper 87.73 to 92.3, phosphorus 0.15 to 0.73, and 17 of the samples containing more than 0.3 per cent. of phosphorus gave an ultimate tensile of over 17 tons per square inch.

(*e*) *Gear Wheels, Pinions, and Worm Wheel Rims.*—These samples contained from 88.5 to 95.5 parts per cent. of copper, and from 0.07 to 1.56 per cent. of phosphorus. But of the 13 of these samples containing from 0.3 to 1.0 part per cent. of phosphorus, all except No. 56 gave an ultimate tensile of 20 tons or over, and No. 56 gave an ultimate tensile of 18.5 tons. These thirteen samples contain from 88.7 to 95.5 parts per cent. of copper.

From a study of these results the writer proposes the following as a provisional specification of the chemical composition of phosphor bronze casting to give in larger castings an ultimate tensile of over 17 tons per square inch and an elongation on 2 in. of not less than 20 per cent.:—Copper, 90 to 92 per cent.; tin, 7.4 to 9.7 per cent.; phosphorus, 0.3 to 0.6 per cent.

There are sixteen samples, the results of the chemical and mechanical tests upon which are given in the tables, namely, from No. 61 to No. 82 inclusive, whose chemical composition agrees with the above proposed specification, and of these sixteen samples one only, and that a small casting, failed to give 17.5 tons per square inch as an ultimate tensile stress, or a percentage elongation of less than 20 per cent. on 2 in.

The above proposed specification is very close to the specification adopted by the Admiralty in 1905 for phosphor bronze material used in the construction of H.M.S. "Dreadnought," namely—Copper, 90 per cent.; tin, 9.7 per cent.; phosphorus, 0.3 per cent. This composition was required to give an ultimate tensile of 17 tons per square inch and an elongation of 15 per cent. on a 6 in. length, and to withstand bending over a 2 in. bar until the two sides were parallel without any cracking taking place. This 1905 Admiralty specification was not, however, based upon the results given in this paper, and it is of interest to see how closely two independent estimations of the best probable chemical composition have agreed.

Some specifications for phosphor bronze compositions with which the writer is acquainted specify the amount of phosphorus to be present in terms of the amount of copper phosphide or tin phosphide employed in the mixture for melting. This method of specification is unsatisfactory on account of its ambiguity. One specification of this character specifies the amount of phosphorus and copper to be employed in manufacturing the copper phosphide used, but notwithstanding this it is not possible by this means to secure that the copper phosphide, or still less the final phosphor bronze alloy, shall contain

* Read before the Institute of Metals.

TABLE I.—*Results of the Mechanical and Chemical Tests of Phosphor Bronze.*

No.	Mark on Sample.	Character of Sample.	RESULTS OF CHEMICAL ANALYSIS.						Ultimate Tensile Strength in Tons per sq. in.	Percentage Elongation on 2 inches	Percentage Elongation on 6 inches.	Results of Bending Tests.	REMARKS.
			Copper.	Tin.	Lead.	Zinc.	Phosphorus	Totals.					
1	921.T.08	Casting	82·3	10·6	6·25	nil	0·54	99·69	15·3	12	...	...	...
2	1377.T.08	Bearings	84·5	14·5	nil	do	0·86	99·86	7·76	1	...	...	...
3	688.T.08	Casting	85·1	14·3	do	do	0·69	100·09	14·56	5	...	...	...
4	2055.T.06	Piston Packing Ring	85·6	10·8	do	2·74	0·82	99·96	8·5	3	...	...	...
5	689.T.08	Casting	86·4	13·0	do	nil	0·51	99·91	14·55	2	...	...	...
6	690.T.08	Ditto	86·6	12·9	do	do	0·41	99·91	14·04	5	...	...	...
7	54.T.05	Gear Wheel... ...	86·8	12·2	do	trace	1·43	99·43	13·4	4·5	..	...	..
8	53.T.05	Ditto	87·0	12·0	do	do	1·56	100·56	13·94	7	...	...	...
9	718.T.06	Piston Packing Ring	87·2	11·2	under 0·3	1·3	nil	99·70	18·0	15	...	...	...
10	1336.T.05	Spanner	87·3	12·2	nil	nil	0·10	99·60	13·69	...	9·3	Broke when bent 49°	Phosphorus too low
11	6606.04	Sheaves	87·4	11·1	do	do	0·49	98·99	18·02	10	...	...	...
12	3108.T.06	Bushes	87·6	11·2	do	do	0·53	99·33	20·8	18·75	...	...	...
13	986.T.05	Sheaves	87·7	10·5	do	1·39	0·35	99·95	18·96	15	...	...	..
14	1908.T.06	Ditto	87·8	8·6	3·3	nil	0·53	100·23	...	...	5	...	Rejected on account of Lead
15	1168.T.05	Piston Packing Ring	87·7	10·7	nil	do	0·97	99·37	23·2	6	...	...	...
16	1194.T.05	Sheaves	88·1	10·5	do	do	0·42	100·02	18·23	12	...	...	...
17	1244.T.06	Boat Hoist Fittings	88·2	10·5	do	do	0·51	99·21	17·8	...	18	Satisfactory	...
18	1902.T.06	Sheaves	88·2	8·8	2·2	do	0·24	100·44	12·7	...	5	...	Rejected on account of Lead
19	2408.T.06	Ditto	88·5	10·5	nil	do	0·55	99·66	15·84	..	9	...	...
20	1150.T.08	Block	88·4	10·1	do	1·34	0·16	100·00	...	...	...	.	Complete article tested to 10cwt
21	1481.T.08	Casting	88·2	11·2	do	nil	0·30	99·70	15·6	12·5	...	...	...
22	1943.T.07	Worm Wheel Rim...	88·7	10·4	do	0·58	0·33	100·01	21·2	34·5	...	...	...
23	516.T.08	Casting	88·9	10·2	do	nil	0·68	99·80	16·4	11	...	...	...
24	1158.T.08	Worm Wheel Rim...	88·8	10·8	do	do	0·07	99·67	14·8 & 8·66	10 & 3	...	...	Phosphorus too low. Duplicate mechanical tests made. Rejected.
25	518.T.08	Casting	88·6	10·3	do	do	0·67	99·77	16·4	11	...	...	...
26	3487.T.06	Capstan Gear ...	88·9	9·9	do	0·7	0·40	99·90	15·7	15	...	Satisfactory	...
27	1494.T.08	Bearing	88·9	10·1	do	nil	0·82	99·72	12·8	10	...	...	...
28	129.T.08	Winch Casting ...	88·8	11·0	do	do	0·52	100·42	15·5	12	...	...	...
29	1982.T.08	Bush	88·9	10·3	do	do	0·77	99·97	19·0	10·5	...	...	...
30	1197.T.08	Sheaves	88·5	10·9	do	do	0·20	99·60	18·2	12	...	...	...
31	2611.T.06	Ditto	88·2	10·6	do	do	0·58	99·58	15·32	...	6·5	...	...
32	3615.T.06	Ditto	88·4	10·3	do	do	0·38	99·08	17·5	...	16·1	...	...
33	3616.T.06	Ditto	88·3	10·1	do	do	0·36	98·76	18·0	...	12·3	...	...
34	517.T.08	Casting	89·0	10·2	do	do	0·71	99·91	16·4	11	..	...	...
35	7014.04	Spindle	89·0	10·1	do	do	0·21	99·31	16·28	7·5	...	...	...
36	1523.T.05	Worm Wheel Rim...	89·1	9·9	do	do	0·16	99·16	12·56	...	3·8	...	...
37	8815.04	Sheaves	89·5	11·3	do	do	0·36	101·16	17·91	15·0	...	...	...
38	596.T.08	Casting	89·4	9·8	do	do	0·44	99·64	16·1	9·4	...	...	...
39	394.T.05	Ditto	89·8	10·0	do	do	0·33	100·13	17·91	16·5	...	...	...
40	591.T.08	Ditto	89·8	9·7	do	do	0·55	100·05	14·3 & 15·2	6·5 & 7·5	...	...	The mechanical tests were made in duplicate.
41	1149.T.08	Bearings	89·7	9·4	do	do	0·78	99·88	20·2	12	..	...	...
42	1205.T.08	Ditto	89·2	9·6	do	do	0·71	99·51	20·1	15	...	...	...
43	1425.T.08	Ditto	89·0	10·1	do	do	0·58	99·68	16·4	27	...	...	..
44	1995.T.05	Sheaves	89·2	9·9	do	do	0·54	99·64	17·3	...	12·5	...	.
45	511.T.08	Ditto	89·9	9·5	do	do	0·33	99·73	20·8	21	...	Satisfactory	...
46	2508.T.06	Ditto	89·0	10·0	do	do	0·50	99·50	14·75	...	2·25	...	...
47	2108.T.08	Ditto	89·3	9·3	0·27	do	0·49	99·66	17·5	22	...	Satisfactory	...
48	4067.T.06	Ditto	89·2	10·6	nil	do	0·42	100·22	18·0	10·4	...	...	...
49	135.T.07	Ditto	89·5	10·3	do	do	0·32	100·12	18·0	12·5	...	...	...
50	3802.T.07	Ditto	89·4	10·0	do	do	0·57	99·97	17·8	...	20·6	...	...
51	1324.T.05	Worm Wheel Rim...	89·1	10·4	do	do	trace	99·40	13·69	..	...	Broke when bent through 45°	Phosphorus too low.
52	1546.T.05	Ditto	89·4	10·2	do	do	trace	99·60	13·60	...	9·3	...	Phosphorus too low.
53	4586.04	Sheaves	89·4	10·4	do	do	0·46	100·26	17·7	11·0	...	...	...
54	1388.T.07	Worm Wheel Rim...	89·7	9·9	do	do	0·28	99·88	24·5	54·0	...	Satisfactory	...
55	2361.T.07	Ditto	89·0	10·0	do	do	0·35	99·85	25·9	48·0	...	...	...
56	1760.T.05	Pinion .. .	89·9	8·9	do	do	0·54	99·34	18·5	...	22% on 5"	Very satisfactory	...
57	1057.T.08	Bushes	89·9	9·8	do	do	0·65	100·35	21·1	20·0	...	...	...
58	2905.T.06	Casting	89·7	9·9	do	do	0·31	99·91	...	...	...	...	...
59	1423.T.08	Bearing	89·1	10·1	do	do	0·72	99·92	18·1	11·0	...	...	...
60	4294.T.07	Bearing	89·3	10·3	do	do	0·38	99·98	16·1	...	...	...	...
61	1493.T.05	Worm Wheel Rim...	90·1	9·1	do	do	0·34	99·54	21·6	..	25% on 5"	Satisfactory	...
62	1547.T.05	Ditto	90·3	9·0	do	do	0·05	99·25	...	...	...	Broke when bent through 49°	Phosphorus too low.
63	1759.T.05	Worm Wheel Rim...	90·4	8·6	nil	nil	0·58	99·58	21·1	...	20% on 5"	Very satisfactory	..
64	1220.T.06	Ditto	90·9	8·8	do	do	0·16	99·86	15·8	27·5	...	...	Phosphorus too low.
65	1108.T.07	Ditto	90·0	9·3	do	do	0·20	99·60	20·4	20·0	...	Bar broke at 90°	.
66	1705.T.07	Ditto	90·4	9·3	do	do	0·46	100·16	27·5	53·0	..	...	..
67	2542.T.06	Stuffing Box ...	90·4	9·6	do	do	0·34	100·34	18·6	24·1	...	...	.
68	8159.04	Sheaves . .	90·4	8·9	do	do	0·73	100·03	18·5 & 20	24 & 26	..	.	The mechanical tests were made in duplicate.
69	2613.T.07	Ditto	90·2	9·6	do	do	0·22	100·02	17·8 & 16·3	7·8	...	...	Ditto.
70	3940.T.07	Ditto	90·4	9·2	0·1	do	0·45	99·95	22·9	31·2	...	..	...
71	183.T.06	Gear Wheel... ...	90·5	9·5	nil	do	0·08	100·08	23·8	54·0	...	...	...
72	444.T.06	Casting	90·0	9·6	do	do	0·42	100·02	13·0	7·5	...	...	...
73	3671.T.07	Sheaves	90·3	9·7	do	do	0·15	100·15	16·8 & 17·5	...	22·0 & 21·8	Satisfactory	The mechanical tests were made in duplicate.
74	585.T.06	Bearing	90·6	8·4	do	do	0·59	99·53	21·0	28	...	Satisfactory	..
75	1008.T.08	Ditto	90·9	8·4	do	do	0·37	99·67	19·2	21	...	Satisfactory	
76	815.T.06	Ditto	90·5	8·9	do	do	0·42	99·81	20·3	20	...	...	.
77	2615.T.06	Sheaves	90·4	8·7	0·18	do	0·53	99·81	17·5	22	..	Satisfactory	...
78	1953.T.06	Bush	90·9	8·8	nil	do	0·46	99·66	20·1	30	...	Satisfactory	..
79	813.T.06	Sheaves	91·3	8·5	do	do	0·37	100·17	18·4	...	16	Bent 90° did not break	..
80	1354.T.08	Bush	91·3	8·2	do	do	0·45	99·95	20·1	30	..	Satisfactory	..
81	812.04	Spindle	91·3	9·0	do	do	0·29	100·59	16·9 & 18·8	16 & 25	...	.	..
82	1581.T.07	Sheaves	92·3	7·2	do	do	0·42	99·92	24·3	50	...	...	..
83	1222.T.07	Elec. Motor Fittings	93·2	5·6	do	do	0·58	100·08	22·4	18·5	...	Satisfactory	..
84	3800.T.07	Bushes	94·4	5·2	do	do	0·45	100·05	16·6	20·0	...	...	...
85	1171.T.07	Worm Wheel Rim...	94·2	4·9	do	do	0·96	100·06	25·0	28·0	...	Satisfactory	...
86	1173.T.07	Ditto	94·4	4·8	do	do	0·98	100·18	24·8	36·0	...	Satisfactory	..

NOTE.—"Satisfactory," under bending test, means that the sample bent without cracking or breaking through 180°

the definite amount of phosphorus required, because indefinite amounts of phosphorus must be lost first in the manufacture of the copper or tin phosphide, and secondly in the melting and casting of the phosphor bronze itself. The only satisfactory method of specifying the amount of phosphorus is to specify the percentage which is to be present in the finished metal, thus allowing the manufacturer himself to proportion his additions of phosphorus in such a manner as to secure the final necessary percentage. Such additions must, of course, vary with the particular practice of melting, etc., adopted.

For phosphor bronze rod, sheet or wire the following specification is indicated by the results given on the table:—Copper, 94.5 to 97.5 per cent.; remainder tin; phosphorus, 0.10 to 0.25 per cent.; ultimate tensile stress when unannealed, over 30 tons per square inch; percentage elongation when unannealed, over 10 per cent. on 2 in.; ultimate tensile stress when annealed, over 20 tons per square inch; percentage elongation when annealed, over 40 per cent. on 2 in.

For phosphor bronze bearings the amount of phosphorus undoubtedly should be high, but what the particular best limits should be the writer is not prepared to state definitely, but it should probably be from 0.8 to 1.0 per cent., or possibly higher.

From the results of the chemical and mechanical tests recorded in this paper there appears to be some indication that in a given phosphor bronze alloy of definite composition containing from 88 to 90 per cent. of copper, the raising of the amount of phosphorus present tends to somewhat raise the ultimate tensile stress, but at the same time lower the percentage elongation of the material. Probably the percentage elongation of alloys used for bearings need not be very high, but hardness, or at least a low co-efficient of friction, is of chief importance. The secret of the value of phosphor bronze for bearings is, in fact, probably due chiefly not to its high ultimate tensile, but to the fact that, as will be pointed out more in detail later, the high-phosphorus bronzes consist of a network of a hard copper phosphide supported and held together in a matrix of a softer copper tin alloy. The bearing surface of the journal is actually this skeleton of phosphide, which possesses a low co-efficient of friction for most other metals, and whilst sufficiently hard to resist abrasion, has its somewhat brittle character rectified by the surrounding and supporting matrix of copper tin alloy.

Table II., giving the results of chemical and mechanical tests made upon all samples of phosphor bronze now under consideration containing over 0.7 per cent. of phosphorus, is of interest, as calling attention to the general properties of bronzes of higher phosphorus content of different compositions.

TABLE II.—*Results of Chemical and Mechanical Tests on Phosphor Bronze Alloys Containing over* 0.7 *parts per cent. of Phosphorus.*

Rotation No.	Mark on Sample.	Character of Sample.	Results of Chemical Tests.				Ultimate Tensile in tons per square in.	Percentage Elongation on 2 inches.
			Copper.	Tin.	Zinc.	Phosphorus.		
2	1277.T.08	Bearings	84.5	14.5	Nil.	0.86	7 76	1.0
4	2055.T.06	Piston Packing Ring... ...	85.6	10.84	2.74	0 82	8.5	3.0
7	54.T.05	Gear Wheel	86.8	12.2	Trace	1 43	13.4	4.5
8	53.T.05	,, ...	87.0	12.0	Ditto	1.56	13 94	7.0
15	1168 T.05	Piston Packing Ring ...	87.7	10 7	Nil.	0.97	23.2	6.0
27	1424.T.08	Bearings	88.9	10.15	Ditto	0.82	18 8	10.0
29	1282.T.08	Bush...	88.9	10.3	,,	0.77	19 0	12.0
34	517.T.08	Castings	89.0	10.2	,,	0.71	16.4	11.0
41	1149.T.08	Bearings	89.7	9.4	,,	0 78	20.2	12.0
42	1205.T.05	,, ...	89.2	9.6	,,	0.71	20.1	15.0
59	1423.T.08	,, ...	89.1	10.1	,,	0.72	18.1	11.0
68	8159. .04	Sheaves	90.4	8.96	,,	0.73	18.5 to 20.0	24.0 to 26.0
85	1171.T.07	Worm Wheel Rim	94.2	4.9	,,	0.96	25.0	28 0
86	1173.T.07	,, ,, ,, ...	94.4	4.8	,,	0.98	24.8	36.0
88	1172.T.07	,, ,, ,, ...	95.5	4.95	,,	0.95	24.6	34 0
89	1710.T.07	,, ,, ,, ...	95.2	3.82	,,	0.86	22.9	43.0

Effect of the Presence of Very Minute Traces of Phosphorus upon Gun-Metal.

It is frequently claimed that in a phosphor bronze casting, it is only necessary that the most minute traces of phosphorus shall be present in order that the material shall possess all the best qualities of a phosphor bronze. Although it is not considered that this claim is correct, yet it must be freely admitted that very small traces of phosphorus in gun-metal alloys are frequently accompanied by remarkably satisfactory mechanical properties. This is particularly shown by the following tabular statement of the chemical composition and results of mechanical tests on six samples of so-called gun-metals. These samples were originally tested as gun-metals, the amounts of copper, tin, lead, and zinc alone being determined. On the receipt of these analytical results the overseer who had sent the samples for test wrote stating that all these samples exhibited exceptionally high and uniform tensile and elongation tests, and, asked as to whether any explanation could be given, it then occurred to the writer that phosphorus might be present, and on being looked for it was found in very minute traces (less than 0.005 per cent.) in all the samples. The general effect of phosphorus is apparently twofold; firstly, it removes any oxygen present in the alloy, thus improving its ultimate tensile and elongation tests; and, secondly, further additions still further increase its tensile and elongation tests up to an amount as high as about 0.7 per cent. of phosphorus, and at the same time increases its hardness, as measured by resistance to abrasion by a file. It has been the writer's experience during recent years that it is tending to become a general practice to add minute traces of phosphorus to gun-metal alloys in which its presence is not required by specification, in order to secure more satisfactory mechanical tests:—

Mechanical and Chemical Tests on Gun-Metals containing Traces of Phosphorus.

Laby. No.	Stamp No.	Ultimate Tensile in Tons. per sq. in.	Elongation per cent on 2 in.	Reduction of area per cent	Copper.	Tin.	Zinc.
3177.T	T.1	19.5	21	20	86.6	11.8	1.6
3178.T	T.2	19.8	20	23	86.6	11 4	2.0
3180.T	T.5	19.7	32	30	86.7	11.7	1.6
3176.T	G.1	19.0	24	23	86.8	11.4	1.8
3181.T	G.3	20.5	25	25	86.5	11.8	1.7
3179.T	G.5	19	27	29	87.0	11.5	1.5

A trace of Phosphorus (less than 0.005 per cent.) was present in all these samples.

Variation in the Mechanical Properties of Phosphor Bronze when Submitted to Different Mechanical and Heat Treatment.

The writer is well aware that in the absence of very definite statements as to the precise heat and mechanical treatment of the samples of phosphor bronze tabulated in this paper a serious cause of variation of an unknown value is introduced, and the deductions to be drawn from the results of this series of chemical and mechanical tests must, therefore, be received with caution, and must not be pushed to extremes; notwithstanding this, it is considered that the publication of all these results will be of value, and that the conclusion as to the probable best chemical composition for phosphor bronze for casting purposes is valid. As some indication of the variations in mechanical properties which different mechanical and thermal treatment of an identical phosphor bronze alloy can produce, the following results of five tests made by Kirkaldy, and published in a paper by C. M. Levi in the "Journal of the Iron and Steel Institute," in 1873, p. 40, are given:—

	Ultimate Tensile in tons per square inch.	Elastic Limit in tons per square inch.	% Elongation (The length upon which this is taken is not stated).
1	33.47	24.81	2.53
2	32.86	24.65	3.20
3	28.36	18.09	9.40
4	24.14	11.75	31.30
5	22.38	9.69	39.10

Phosphor Bronze Wire of Special Composition.

The present Admiralty specification for phosphor bronze wire for braiding electric cables requires it to be made of a mixture of pure tin, not less than 5 per cent., and pure copper, and to have a breaking stress of not less than 20 tons per square inch of section, with an elongation of not less than 42 per cent. in a length of 5 in. As a matter of interest the analysis of a sample of phosphor bronze wire for braiding electric cables is here given, viz.:—

	End "A"	End "B"
Copper	92.850	92.900
Tin	6.500	6.550
Phosphorus	0.314	0.322
Lead and zinc	Absent	Absent
	99.664	99.772

The analyses were made from samples cut from opposite ends of a 3 ft. length. The composition exhibits remarkable uniformity, and the chief interest which attaches to it is that two or three makers have stated that such material cannot be manufactured, as it contains too much tin and too much phosphorus. The results of the mechanical tests on this material are unknown, but it possesses remarkable toughness and resistance to bending fracture.

The Condition in which Phosphorus Exists in Phosphor Bronze.

If sections of samples of phosphor bronze containing from 0.1 to 2.0 parts per cent. of phosphorus are prepared and polished and examined under the microscope, without etching or colouring in any way, by means of vertical illumination, it will be noticed that as the phosphorus contents rise a network of pearly grey colour can be distinguished in increasing amounts clearly outlined against the redder colour of a copper-tin alloy. This effect, although readily apparent to the eye, is not easily photographed, and it is considered that for a uniformity of examination it is desirable to as far as possible avoid the use of etching or colouring effects. The difference in apparent colour between the greyer and the redder constituents is very much like that seen when the disc of the full moon is seen low on the horizon, the markings on the moon contrasting with its reddish higher lights in very much the same tints.

It is considered that when phosphor tin or phosphide of copper is added to copper or a copper-tin alloy the phosphorus combines with the copper, the tin being reduced to the metallic state, and on cooling the copper phosphide separates out in a pure or nearly pure form and gives rise to the grey network observed, whilst the redder matrix consists of the copper or copper-tin alloy containing very little, if any, phosphorus.

Special Characteristics of Phosphor Bronze.

The special characteristics of phosphor bronze are:—(1) Its freedom from corrosion by salt water, which is apparently largely due to its freedom from zinc; (2) its high qualities as a mechanical constructive material, as compared with an ordinary zinc-free bronze; (3) the small effect which rise of temperature has upon its mechanical properties, which remain practically unimpaired at temperatures at which zinc containing copper alloys exhibits serious drops in strength; (4) a spark cannot be readily obtained from it by a blow; (5) phosphor bronzes of high phosphorus contents possess low friction co-efficients for most metals, and are hard enough to resist abrasion well.

On account of the above properties, phosphor bronze is particularly suited for boiler fittings and for fittings exposed to sea water, for the construction of machinery for manufacturing explosives, and for bearings for high-speed machinery.

Mr. J. Culverwell, Eastover Foundry, Bridgwater, notifies us that he is shortly relinquishing business.

The Vulcan Foundry Company, Limited, of Newton-le-Willows, have just secured an order for 51 locomotives for the Indian Railways. Of these 15 will be for express service and the remaining 36 will be of the standard goods type for mineral traffic.

A meeting of the shareholders of the Aluminium Corporation, Limited, was held in London, recently, to consider a resolution to wind up the company "on the ground that it was unable by reason of its liabilities to continue its business." Sir James Sivewright presided, and dealt with the unfortunate circumstances that had brought about the misfortunes of the company, especially the fall in the value of metal. A discussion ensued, and eventually the resolution for winding up was carried.

Mr. F. Collier was the recipient at a recent meeting of the Birmingham Branch of the Friendly Society of Ironfounders, of a presentation on the occasion of his leaving England to take up a position as foreman in the Indian Government workshops.

William Mills, Limited, of Bonners' Field, Sunderland, and Grove Street, Birmingham, who make a speciality of aluminium castings, have installed a complete system of hydraulic machinery for producing machine-moulded aluminium castings.

Messrs. G. C. Samuel & Astbury, 41, International Exchange, Edmund Street, Birmingham, have been appointed Midland representatives for Messrs. Newman, Hender & Company, Limited, Stroud, Glos., and Messrs. A. & P. Steven, Provenside Engine Works, Glasgow.

The "Bosshardt" Casting Process.

Iron-makers have for many years been desirous of producing a material that would combine the qualities of malleable iron and steel and be suitable for use in general foundry work, while at the same time not requiring the annealing which malleable castings are subjected to. Various inventors have at different times come forward with suggestions and processes claiming to cover the case, but up to the present nothing very remarkable has come into general use.

The latest claim to success in this direction is the "Bosshardt" casting process, which is now in use at works in France and Holland, and has been in operation two and four years respectively at those works. The resulting castings, it is claimed, possess perfect homogeneity in regard to malleability, and no other operation, beyond the usual cleaning, is required.

Four qualities of castings are produced, namely, soft and forge iron, extra soft steel, soft steel, and a hard steel for tools, each quality possessing distinguishable properties. The first is a readily malleable metal, and easily weldable to itself or other weldable metals. Castings made from this quality, it is stated, may be twisted and hammered cold. The second quality is also malleable, but is more difficult to weld than the first, the first having more elongation, and the second greater strength. These two qualities, it is stated, are very applicable to the making of screw propellers, and these have already been cast by the process. The third quality corresponds to soft steel and the fourth to hard tool steel. For the purpose of cutting, this latter steel is claimed to render the same service as the well-known "Bohler" steel.

For the purpose of fusing the metal in the melting pot, a special furnace, which produces a high and uniform temperature of about 2,000 degrees C. throughout, has been adopted and patented. The introduction during the fusion of the metal of chemical products into the metallic mass in order to refine it and give certain necessary qualities to the metal, is a principal feature of the process. The use of a special coating in order to reduce considerably the wear and tear of the metal-pots and crucibles and to keep up and preserve the interior of the sides of the furnace is also a feature. The materials used for producing the metal are scrap iron and steel, waste resulting from the manufacture of nails, bolts, rivets, horse shoes, chains, links, Swedish iron, ends of bars, etc.

The melting pots or crucibles, containing about 80 lbs. of metal, are placed upon sand supports, and are covered over with an extremely fine sand. The fire being then lit with charcoal, furnace coke of a good quality and low sulphurous properties is put in and the blast is then turned on. The absence of all chilling increases more the preservation of the refractory coating of the furnace and melting pots, which are already protected by the application of the special coating.

The arrangement, disposition, and construction of the melting furnace allows the waste heat to be utilised; instead of allowing it to escape by the chimney it is passed into a second furnace, where the temperature, rising to about 1,200 degrees C., may be utilised to make the material red hot, or to heat the metal-pots before they are put into the fusion furnace.

The duration of the process of fusion does not much exceed 2½ to 3 hours for the casting of No. 1 and No. 2 qualities, and from 1½ to 2½ hours for steels of the No. 3 and No. 4 qualities. The metal, when hot, is particularly fluid, permitting of the manufacture of castings of a complicated nature. The loss of metal during fusion may be estimated at from 8 to 10 per cent. The sand used in the melting process is a special and secret preparation.

It is found the most desirable to construct the furnaces so as to hold four melting-pots of a capacity of about 80 lbs. each pot, and from each furnace an average of three melts per day can be obtained. The cost of erecting two such furnaces, including the necessary tools, brickwork, chimney stack of suitable height, and other materials, is stated not to exceed at a liberal estimate £750.

The following interesting figures regarding the cost of the metal after coming out of the furnace have been compiled by the company operating the process: —

	£	s.	d.
Cost of material per 220 lbs., including the addition of chemical products	0	8	4
Special coatings and sand for melting pots	0	2	1
Wear and tear to melting pots	0	6	3
Coke at 16s. 8d. per ton	0	3	1½
Furnace repair, refractory linings, and motive power...	0	1	0½
Labour, one man for two furnaces, at 5s. 10d. per day ...	0	1	0½
Cost of moulding (essentially variable) and cleaning or fettling of castings	0	2	11
Cost per 220 lbs.	1	4	9½

This would indicate that castings can be produced at rather less than 1½d. per lb. entirely finished, and ready for delivery to the customer.

Numerous tests have been made with the metals produced by the "Bosshardt" process, and some results are stated to be as follows: —

1. Cylindrical bars of 20 mm. (about 3 in.) diameter and 40 mm. (1⅝ in.) in length, after having been allowed time to cool, were bent by a hammer until the two extremities were in contact, and the bend itself flattened by the hammer. No cracks or breakage on the outer side occurred.

2. Two similar bars were welded directly together at the forge without the use of any welding substance. This was accomplished easily, and after being allowed time to cool, the piece was bent on the weld to the point of rendering the two ends parallel. The weld did not present any crack, and appeared perfectly homogeneous.

3. A cast piece of rail was held in a vice, the foot of the rail being then hammered back against the vertical section or body of rail without the bend presenting any crack from without.

4. A spiral, twisted cold from a bar similar to those used for the aforesaid tests, was unrolled cold.

5. A piece detached from a motor (foot of spring) cast in Ardennes steel, was broken in several pieces under the blows of a small, light bar; when the same piece or part of the spring was made in accordance with this process, and submitted to the repeated blows of a heavy steam hammer, it flattened without presenting any crack.

MESSRS. F. BATES, A. BATES, AND W. G. BATES, ironfounders, etc., Winsford, trading under the style of James Bates & Sons, have dissolved partnership so far as regards Mr. F. Bates.

Preparing and Conveying Moulding Sand in the Foundry.

By J. Kraus.*

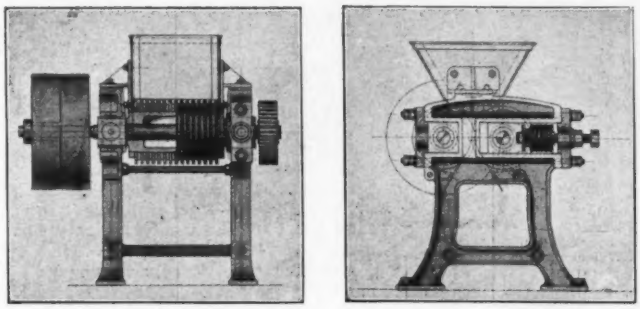


FIG. 1.

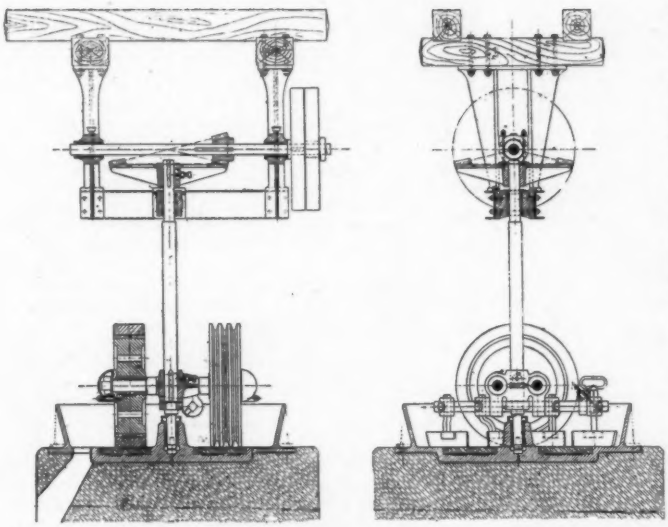


FIG. 2.

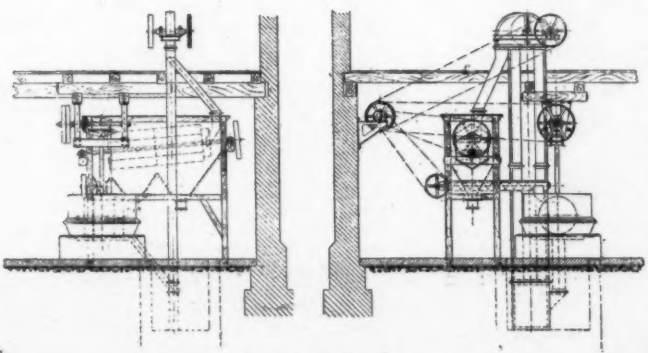


FIG. 3.

The important influence of moulding sand on the uniform quality of castings and the prevention of defective pieces, renders the testing and preparation of the sand and loam one of the chief tasks in foundry practice. Pure quartz sand, even when obtainable, cannot be used alone, but requires mixing with clay or loam to serve as a bind and impart plasticity and resistance to the pressure of the metal in the mould. Angular, fine-grained sand is the best, as it affords a hold for the particles of clay and increases the strength of the mould better than sand which has been ground too fine.

Clay, owing to the presence of aluminium, becomes plastic when moistened, and retains its form when dried again. This plasticity varies inversely with the amount of sand added, and when this latter exceeds 90 per cent. of the mixture, the strength of the moulds is greatly impaired, and they can no longer be dried properly, but must be used in a damp state. On the other hand the porosity of the mould to gases increases with the proportion of sand in the mixture; and it therefore becomes necessary to adjust the relative quantities of the two ingredients so as to retain both the above-mentioned properties as far as possible, in order that a coherent dry mould may be obtained on the one hand, and sufficient porosity on the other, to allow the steam and gases to escape without spoiling the casting by bubbles. Moulding sand too rich in clay to be sufficiently porous, may, however, be improved in this respect by heating it to about 400 degrees C.

A desire to secure porosity should not lead to insufficient grinding of the sand, or the result will be rough castings with imperfect edges. The happy medium is obtained by grinding the sand, in general, till it will just pass through a screen with about 50 meshes to the inch, taking care to avoid the formation of any large proportion of very fine particles capable of stopping up the pores of the mould.

The aforesaid burning of the clay in the mixture always takes place when the moulds are used, the sand growing less and less rich, and requiring to be regenerated by the addition of fresh material. Consequently, a two-fold task is imposed on the moulding sand department, namely, preparing new sand, and regenerating that already in use, to say nothing of the grinding and incorporation of coal with the mass, to generate gas and prevent the sand burning on to the castings.

* "Stahl und Eisen."

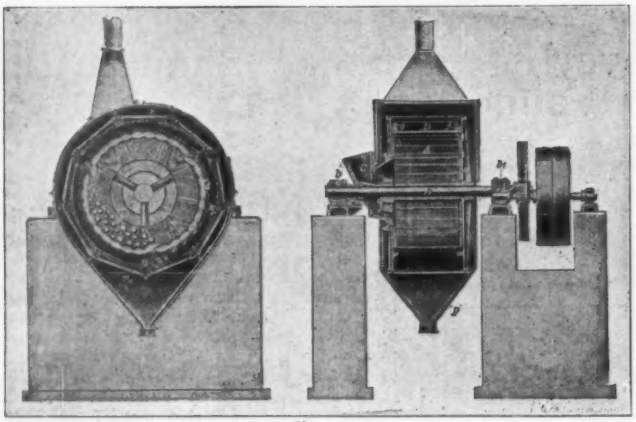


FIG. 4.

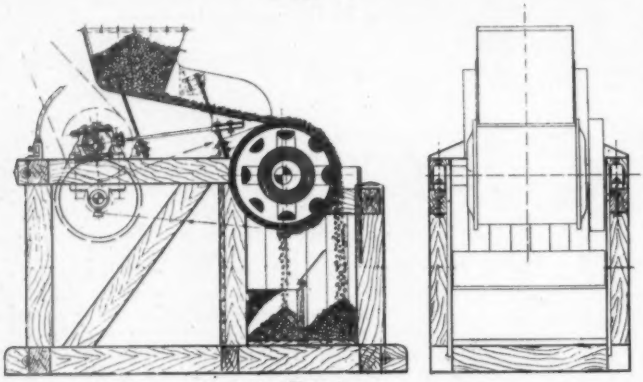


FIG. 5.

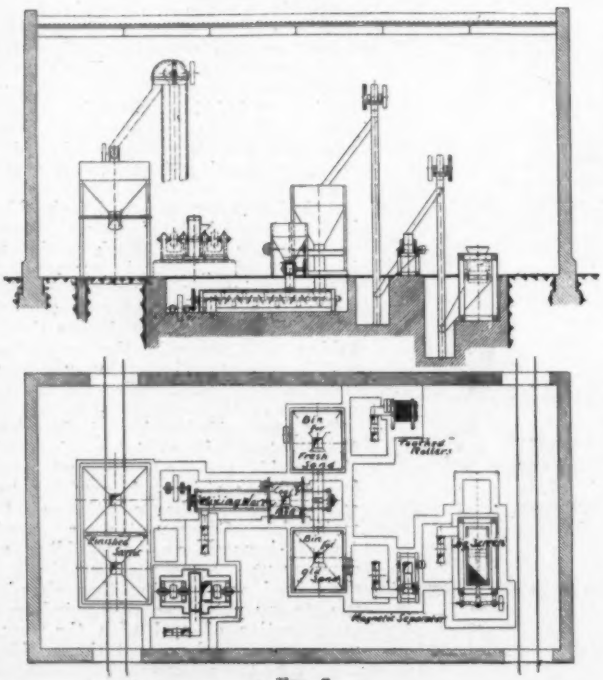


FIG. 7.

The following mechanical appliances are required for the preparation of moulding sand: crushers for reducing sandstone or coarse sand; driers for wet sand; screens; mixers with automatic proportional feed; magnetic separators for removing particles of iron; mills for grinding the coal; sprinklers, and finally conveyors for various purposes. Sandstone is crushed in stone-breakers of the ordinary type; soft sandstone or lumpy sand being treated in a crusher (Fig. 1) consisting of two rollers made up of a number of toothed discs, which are interchangeable, the size of the teeth varying with the material to be treated. From these machines the sand is conveyed to an edge-runner mill with fixed trough and movable runners driven from below. To prevent the well-known grinding action of the extreme surfaces of the runners from rubbing down the sand too fine, the runners should not be more than 4 ft. in diameter.

A better type of edge-runner mill for moulding sand is that illustrated in Fig. 2, with overhead drive, the one runner being grooved to act as a crusher and thus save the use of a preliminary machine, whilst at the same time better mixing is obtained. Whilst these machines can be made continuous in action by fitting grids or screen plates in the trough, the most efficaceous method in the case of large plants is to arrange an elevator in the rear of the edge runners (as shown in Fig. 3), to raise the crushed sand into a revolving screen. The screenings are discharged into trucks or storage hoppers, and the coarse sand is returned to the mill by a worm conveyor.

A simpler method of crushing and screening the sand is by means of a ball mill, but this is only feasible in the case of dry material and where very fine grinding is unnecessary. The mill can also be advantageously utilised for regenerating old sand and for grinding the coal. The forged steel balls rotate in contact with perforated grinding plates or corrugated bars, the latter being preferable as presenting a larger working surface and preventing the balls from rolling down too soon. This increases the output and protects the metal casing, since most of the work is performed between the balls themselves. The ground sand falls through slits on to a double screen, consisting of an outer screen of perforated metal and an inner one of wire gauze, the coarse material being returned to the mill for further treatment. The finished sand is stored in heaps, bins, etc., according to the size of the works.

Used sand is regenerated by screening out the lumps, stones, and particles of wood, and is then put through a magnetic separator (Fig. 5) to remove particles of iron that have found their way in during the casting process. This separator consists of a drum, the surface of which is magnetised during a certain portion of a revolution, so that the particles of iron contained in the sand dis-

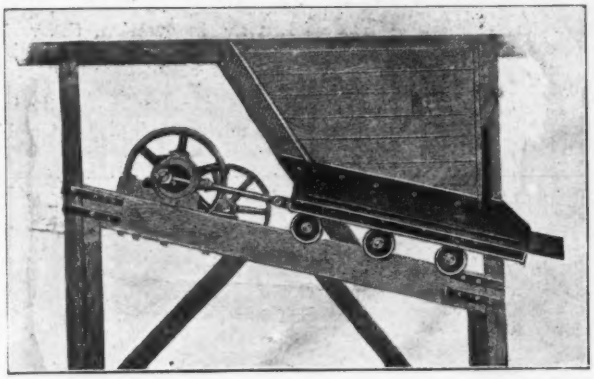
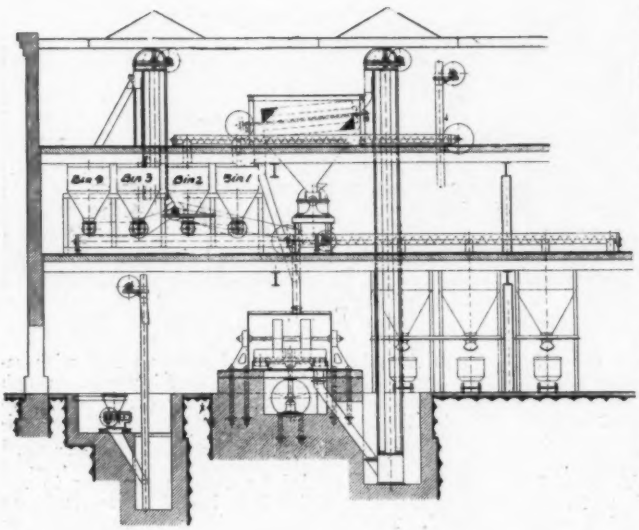


FIG. 6.



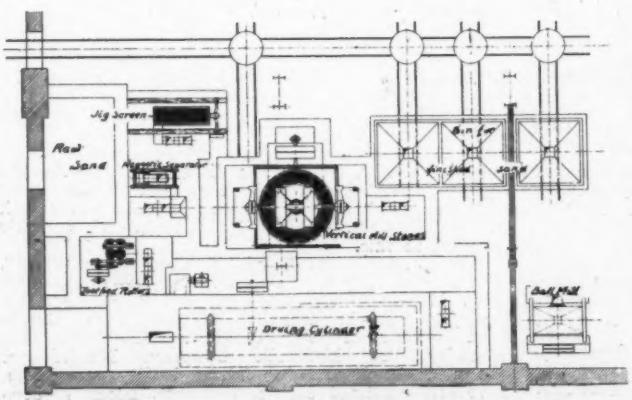


FIG. 8.

tributed over that surface by means of a shaking feed hopper, are retained by magnetic attraction until they reach the point where demagnetisation is effected, whereupon they fall down into a receiver, the non-magnetic portions having previously fallen off into another receiver. The magnetising coil is mounted in a fixed position inside the drum, whilst the poles are mounted so as to rotate about the coil, upon an eccentric pole shaft, so that only the poles on the front half of the drum attract the iron, those on the rearward half being too far away to have any action on the particles of metal, which are consequently released. Only a very small amount of current is required for operating the magnets.

The once-used sand is stored and afterwards mixed with fresh sand in certain proportions, preferably by means of the apparatus shown in Fig. 6, the process being completed in a centrifugal breaker and mixer containing concentric cages rotated at high speed in opposite directions so that the sand is dashed against the peripheral bars of the cages and all lumps are broken down. The finished sand is then ready for storage in bins or heaps.

The carbon coal to be mixed with the moulding sand is ground very fine in a ball-mill and incorporated with the sand in a moistening and mixing archimedean conveyor.

Various types of conveyor are required to handle the large masses of sand and transport it from one part of the works to another. They comprise cup elevators for wet and dry sand, jig conveyors, worm conveyors, endless belts and endless belts with scrapers. Worm conveyors are unsuitable for sand containing particles of iron, or such as is likely to ball; whilst jig conveyors can only be used where there is a solid foundation for their support. Endless belts, of rubber, balata or hemp fabric, again, though very useful for a variety of purposes, are unsuitable for hot materials; and iron particles cause them to wear out prematurely. Finally, trough-shaped conveyors are expensive, owing to the necessary large dimensions in view of the relatively low working speed, to say nothing of the considerable wear and tear. The endless belt, fitted with scrapers, is, however, suitable for any kind of material, the only drawback being the large consumption of motive power, especially when the conveyors are lengthy. In view of these facts, the choice of conveyor to be used must depend on the particular circumstances of each case.

The plant illustrated in Fig. 7 should be set up at one side of the foundry, being separated therefrom by a yard. The used sand is brought into the mixing house in trucks and passed through a jig screen ($\frac{1}{4}$-in. mesh) to remove lumps, fragments of wood, etc. An elevator conveys the screened sand to the iron separator, which delivers the par-

ticles of iron into a truck, whilst the purified sand is elevated to a storage bin.

The fresh sand is passed between toothed rollers and elevated to the storage bin. Both these bins are fitted with adjustable devices, operated by eccentrics and connecting rods, by means of which the old and fresh sand can be discharged in the desired proportions for mixing. The ground coal from the ball-mill is stored in a hopper, also fitted with a discharging apparatus, consisting of a roller divided into compartments, the speed of which roller controls the rate of delivery.

All the above materials are discharged into the mixing worm underneath, from which, after being moistened, they are raised by an elevator to the centrifugal mixer and breaker and thence into storage bins from which the finished sand is transported in trucks to the foundry. Where several different grades of sand have to be used, a larger number of storage hoppers will be required, or the material can be kept in heaps, from which it is shovelled on to trough-conveyors and taken to hoppers near the moulding machines. In such cases the used sand is passed through the iron separator on its way out of the foundry to the storage heaps.

In one new foundry the moulding boxes are emptied on to gratings, through which the used sand falls on to a belt conveyor underneath, the dust being removed by exhaust fans.

A typical arrangement of plant for dealing with various grades of sand, to produce a moulding sand of high quality, is illustrated in Fig. 8. Here the fresh sand is put into a drying cylinder (Fig. 9), which is more economical than the old form of drier. The cylinder is long and narrow, and is fitted with internal scrapers, the heating gases ascending through it and drying the descending sand. It will also burn clayey matter if the rate of feed re reduced. Air is blown into the furnace by a fan, through two passages below the fire and one above, the latter ensuring smokeless combustion and carrying off the water vapour. The evaporative effect is about three times that of the ordinary drying kiln.

The dried sand is delivered into the bin No. 1 (Fig. 8). Another grade of sand, consisting of soft sandstone, is passed through a breaker, dried, and delivered into No. 2. No. 3 is for the coal, which has been ground in another room; and No. 4 is for purified used sand, the latter being treated in the way already described.

As fine art castings are in question, the various materials have to be very fine and intimately mixed. The percentage proportions are delivered from the bins by means of rollers divided into compartments and run at controllable speeds, discharging into a mixing worm fitted with mixing blades. This machine

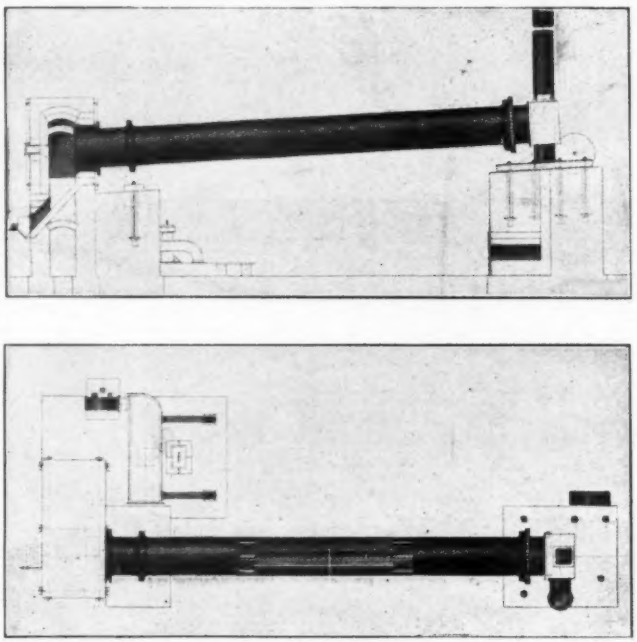


FIG. 9.

delivers the mixture to an edge-runner mill with revolving trough, and the ground sand is passed through a drum screen which returns the coarse particles to the mill, the fine sand being put through the centrifugal mixer, the hopper of which is fitted with a water-spraying device to moisten the sand. The finished sand is carried by a worm conveyor to the storage bin, from which it is loaded on to trucks as required. This plant was designed by de Dietrich & Company of Niederbronn, and constructed by the Humboldt Company, Kalk, Germany.

THE Admiralty have decided that officers on the active list, on full pay, or holding appointments under the Admiralty, shall be forbidden to hold the post of director of a company. The necessary alterations will appear in the King's regulations. The order will affect, amongst others, two Sheffield firms, Lord Charles Beresford being chairman of directors of John Hy. Andrew & Company, and Admiral Sir A. L. Douglas being a director of Hadfield's Steel Foundry Company.

THE petition of John Shaw & Sons (Wolverhampton), Limited, for the compulsory winding-up of the Reading Iron Company, Limited, was again mentioned to Mr. Justice Neville in the Chancery Division, recently. Counsel stated that the petitioners had been in communication with the other creditors, and they thought it would be desirable to have an adjournment. He therefore asked that the petition might stand over until the second winding-up day of next term. His Lordship assented to this.

MESSRS. SCRIVENER, BREFFIT & COMPANY, of Cardiff, who were recently appointed Welsh agents for Richardsons, Westgarth & Company, Limited, of Middlesbrough, will in addition represent the Hartlepool branch of the company. The Leeds Engineering and Hydraulic Company, Limited, of the Oaklands Engineering Works, Rodley, near Leeds, have also appointed Messrs. Scrivener, Breffit & Company as their agents in the South Wales district for the sale of their numerous manufactures.

Foundry Practice.

Cleveland Institution of Engineers.

The members of the Cleveland Institution of Engineers held their second meeting of the forty-fifth session at Middlesbrough on Monday evening, December 7, Mr. E. Hall Craggs, the President, in the chair.

Mr. Sidney G. Smith, Staveley Ironworks, Chesterfield, read a paper on "Foundry Practice, with Reference to some Principles and Precautions in the Iron Foundry." Of this the following is an abstract:—

Moulding.

This paper deals with foundry practice, with special reference to some principles and precautions in the iron foundry. The author says that foundry practice is a large field, and includes iron, steel, brass, bronze, and many other alloys used for practical and decorative purposes. He considers the question of iron founding. With respect to the business of moulding it is stated that to a moulder who takes his work seriously there is no trade which demands more forethought and sound judgment, and which gives a man so much worry. In a general foundry there are castings which are made in green sand, dry sand, and loam. These are the three different methods of moulding. The kind of casting required, its soundness and economy, determine by which of these ways it should be moulded. Green sand means sand containing moisture. Moulding sands for foundry purposes differ in colour and consistency, some sands containing more binding properties than others, and they are classed as weak, medium, and strong. The weak sand is used for light castings, the medium for heavier ones, and the strong for very thick castings. Any of these sands can be toughened correspondingly to the binder they contain if ground in the loam mill. Mr. Smith gives particulars of the precautions to be observed when casting in each of these three methods, and deals also with the making of cores.

The Foundry Chemist.

In treating of the founding of iron the author states that in a paper read before the Cleveland Institution of Engineers, in the early part of the present year, and which was entitled "Foundry Practice, with Special Reference to Marine Work," nearly the whole of the discussion revolved upon one sentence. This was "Foundries which have dabbled with chemists." The author says he likes to dabble with chemists, to whom we owe so much, and without whose help it would be impossible to treat this subject in an intelligent way. He believes it is possible, with the chemist's assistance, to collect an amount of information that would be invaluable to iron founders. Mr. P. Munnoch in that discussion said that practically very little was known of the properties and peculiarities of cast iron. With that opinion the author agreed. Something might be done towards standardising chemical mixtures for different kinds and classes of work. Generally speaking, the constituents of cast iron are as follows:—Carbon in its two forms, combined and graphitic, silicon, manganese, phosphorus, sulphur, and possibly traces of other metals and metalloids. Perhaps, with the exception of sulphur, the other constituents are necessary for combining and uncombining the carbon, liquidising, etc., and even sulphur may have some redeeming feature in chilled castings. The effects of the metalloids are:—Combined carbon in degrees gives hardness and strength; graphitic carbon softens and toughens in degrees; silicon softens by its influence upon the carbon when that content is not in excess; it also promotes fluidity. Phosphorus also promotes fluidity, but if in excess causes brittleness. Sulphur hardens the iron, increases contraction, and causes sulphur holes. Carbon and silicon are the two principal constituents that require control. Mr. Smith gives a table showing the effect of different percentages of silicon in transverse and tensile strengths. The best results are shown in transverse strength with 1 to 1.40 per cent. silicon, and in tensile strength with 1.9 to 2.2 per cent.

It is stated that as pure iron is useless, and only exists as a curiosity, it is only in combination with other metals and metalloids that it becomes of practical use.

Pig-Iron Mixtures.

Founders mostly have hitherto decided their mixtures by fracture; even on the pig-beds where chemical analysis should commence the metal is classed generally by fractures. This method is now condemned as unreliable. But is it so unreliable? Competent foundrymen in the past have not gone very far astray in selecting the metal by fracture and other tests which are not chemical. To do so with good results a knowledge not only of the appearance of Nos. 1, 2, 3, and 4 irons is needed, but also the districts where the iron is made. In selecting scrap there may be some uncertainty, unless it is known where it came from.

With reference to mixing iron by analysis, there is no doubt it is the most scientific method when it is established that a given analysis will produce a mixture of iron that will be satisfactory for different classes of work. In general foundry work there are many matters to consider. A mixture of metal that would be suitable for a cylinder would be quite unsuitable for a large pulley. The author said he might enlarge on the different kinds of work which require close and open grain, toughness and hardness, tensile and transverse strength. It is also to be remembered that different mixtures will vary in contraction. These are some of the things that have to be thought out in mixing metals, and if the chemist is to be a success in the iron foundry, these are matters in which he must be trained. The chemist who is only a chemist to check the analysis of iron delivered would be useful only in that part. To be of any use to the foundry, he must be something of an engineer, and should know what mixtures would be suitable for different classes of work. At a meeting of the Middlesbrough Foremen Engineers' Association, it was stated that the person wanted in a foundry, to be of practical value, was a metallurgist. It had also been said before the Cleveland Institution of Engineers that what is wanted in the foundry to-day is a metallurgical engineer, who need not necessarily be a chemist, but who can interpret the analyses obtained by a chemist. When foundry foremen acquire metallurgical knowledge they will be the most suitable men to control what goes into the cupola.

Design of Castings, Shrinkage, etc.

The question of shrinkage, draws, crystallisation, design, etc., are matters that should have more attention in the engineer's office. There are more faulty

castings from bad designs than from bad iron. Uniformity in thickness is the principle that must not be overlooked in cast iron, and the more consideration this principle has the better it will be for the founder and engineer alike. It is difficult in many cases to have uniform thickness, but thick sections close to thin sections are often a source of weakness rather than of strength.

Mr. Cook, in his Presidential Address to the British Foundrymen's Association, held at Newcastle in August, gave some interesting results of irons of the same analyses, but which differed widely in transverse and tensile strengths. The writer has had similar experience—instances where the conditions have been identical regarding temperature, cooling, and moisture, where the results were different. He has had test bars made in the same box cast at the same time, and there has been a difference of 3 or 4 cwts. in the transverse break and a corresponding difference in deflection. These differences often cause the foundry foreman much worry and anxiety, and it appears that analysis will not solve the difficulty.

Blow-holes, etc.

Mr. Smith discussed the question of the globules of metal found in blow-holes of castings which were mentioned by Mr. J. E. Stead in an address on iron, sulphur, and phosphorus. These shot cavities are mostly found near the top of castings and seldom the bottom. His experience with respect to shot cavities is that they are mostly developed in iron which is rather hard; they are seldom found in a soft rough iron. The harder the iron the greater its tendency to be irritable when poured into the mould. It would be a great advantage to the foundryman if the true cause of the phenomena could be discussed. Shot cavities and hard spots in iron cause a great amount of trouble in the fitting shops. Another phenomenon is that soft, hard, and white iron can be cast at one time from the same ladle. The author supposes the explanation is this—that when the iron is forced into a small space it rapidly sets, so rapidly that solidification has taken place before the carbons have had time to separate, and this goes to prove that graphitic carbon does not exist in metal in a molten state.

Temperature at Pouring.

With regard to the temperature at which a casting should be poured, that depends on the shape, size, thickness, the area of the runner gates, and, if a naturally cast mould, some consideration for pressure. It is questionable if there can be any definitely fixed temperature in general foundry work that would be of any great advantage. An experienced and observant foundryman has no great difficulty in gauging the heat of the iron to suit the work in hand.

Alloys.

With reference to the use of alloys—manganese, titanium, silicon, chromium, and nickel—some look upon it as doctoring the iron. The author considers that the knowledge of alloys and their influence is a distinct advantage to those who have different classes of work requiring different mixtures of metal. If by adding ferro-alloy to the iron a cleaner, stronger, and more durable casting could be got, free from honeycombs, cavities, and sulphur holes, a dense and even grain that will possess good machining qualities, iron that will give better results in physical tests, is it not experimenting in the right direction? Alloys will often supply the element in which the pig may be deficient, because the best brands of suitable iron are not always to hand. The author believes that chrome and nickel give great strength to motor cylinders. Manganese and titanium are closely allied in their influence; both stiffen and render closer the iron, up to 1 per cent. The advantages of steel being added to iron in the ladle and cupola are well known.

Cupolas, etc.

In respect to cupolas there are several types, each claiming some advantage in melting iron with economy. The ordinary cupola, however, in the author's opinion, gives as little trouble as any of them.

The author concludes by a few supplementary remarks on crystallisation, loam moulding, and core sand, and definition of blow.

Discussion.

In the discussion the President read a letter from Mr. Alexander S. Keith, of Leeds, in which he remarked how few founders took any definite analyses of their iron, and were still pursuing the old rule-of-thumb practice—judging their iron by fracture. They appeared to get good results and make money. He asked what was the average percentage of loss in melting in foundries, say, from the pig to the finished casting, when making large castings?

Mr. J. E. Stead, Middlesbrough, in a communication, remarked that to depend absolutely upon fracture of pig-iron was not to be recommended, for as was well known, No. 1 pig-iron might contain anything from 1½ to 4½ per cent. silicon. It very often happened that very close irons might also be very high in silicon and sulphur, and on that account the fracture was very misleading. The assistance of the analysis enabled the founder to ascertain qualities which the appearance of the fracture alone did not reveal. On many occasions he had been asked why No. 1 or No. 3 pig-iron gave thin castings which were hard and white. The foundrymen who sent the samples judged entirely by fracture, but the analyses at once showed why the castings were white, for they were exceedingly low in silicon, and sometimes high in manganese. Had it been known what was in the pig-iron, the silicon content could have been corrected by the addition of pig-iron containing high percentages of silicon. It was a mistake to assume that when recommending analysis it was to be understood that the founder was not expected to look at the fracture at all. Mr. Stead dealt at some length with the questions of shrinkage, shot in cavities, etc.

Mr. Thos. D. Wilson (Wilson, Copley & Company), Middlesbrough, held that classing by fracture was not practically unreliable in general iron-foundry work. In foundries where a uniform class of castings were made, then the chemist was invaluable, because of the uniformity required on castings varying in weight from a few pounds to as many tons; in such a case the experienced foundry manager or foreman had the advantage over the chemist. In speaking of tensile and transverse test bars, the author had been surprised at the different results obtained from bars made under uniform conditions; these results varied very considerably. After forty years' foundry managing, he might say from experience that such bars were a very unsatisfactory test of cast iron.

Mr. Ebenezer Adamson (Seaton Carew Ironworks), Seaton Carew, spoke at considerable length; he said the paper was one of the best that he had heard. The author brought into prominence many of the difficulties of iron founding. He had had some experience with test bars. Physical tests gave different results, but at the same time analysis alone was not a reliable guide. Theoretically, to make iron according to analysis was the most scientific method.

Mr. H. Stonewall Jackson (Messrs. Richardsons, Westgarth & Company), Middlesbrough, thought the pig-iron now obtainable was not quite so uniform in

character as it used to be. Pig-iron which was supposed to be uniform often contained silicon varying from 1.4 to 4 per cent. When they came to iron of that nature it was almost impossible to turn out high-class castings unless the iron had been analysed. Ironfounders had been driven to analyse the whole of the materials they dealt with. He agreed that test bars were often unreliable. The question of temperature should receive more attention. Castings were often faulty because they were run at too low a temperature. With regard to ferro-alloys, if the founder had no chemist he should leave these severely alone; if a chemist were employed then they might use them advantageously. He might say they had found the laboratory at their works a distinct advantage.

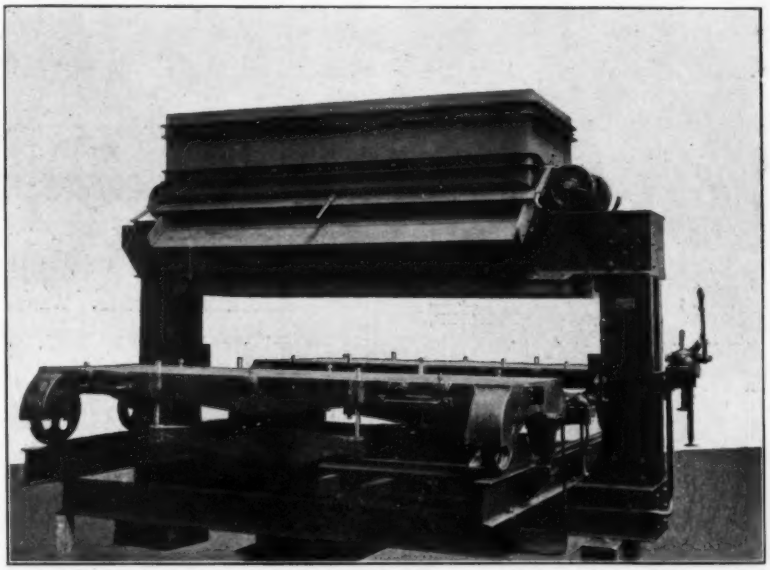
After a few remarks by MR. MUNNOCH, of Middlesbrough, MR. H. B. TOY, Haverton Hill, said he happened to be one of the unfortunate ironfounders who had to pay high prices for his pig-iron, for he needed special iron—hematite cold blast. They could not get the tests from local iron or he would not purchase the high-priced iron. They found it was absolutely necessary to select by chemical analyses, and could not trust the fracture. They got six different brands of cold blast iron, and the manganese in them varied from 1.3 to 0.8 per cent. Not only had they to engage the services of a chemist, but also those of a practical metallurgist.

MR. F. HERBERT MARSHALL (Tees Ironworks), Middlesbrough, said Mr. Jackson had referred to local iron as not being as uniform in quality as was once the case. But if he insisted on buying his iron in the open market, in competition with buyers who called for no special quality, he must take what was generally sold. If he wanted iron made to special analysis he must pay extra for it.

After a few remarks from MR. MATHER, of the Steel Strip Company, Middlesbrough, MR. SMITH replied shortly, but undertook to reply at length in writing to the numerous queries and criticisms of the various speakers.

Moulding Machine for Coke Oven Doors.

We illustrate herewith a large moulding machine recently manufactured at the Royal Würtemberg Works, at Wasseralfingen, Germany, for a leading German concern.



HYDRAULIC MOULDING MACHINE FOR COKE OVEN DOORS.

The machine, which is intended specially for moulding coke oven doors, takes boxes of about 38 in. by 110 in., with 12 in. depth, and is probably one of the largest hydraulic moulding machines hitherto manufactured. It is fitted with an automatic sand reservoir feeding the moulding sand into the boxes. The boxes are carried on two mould carriages placed on either side of the rectangular frame and running on rails. The machine is built for hydraulic moulding; it has two pressure pistons, and is fitted with a hydraulic lifting device for the boxes. It is capable of moulding ten coke oven doors per day, with the aid of four workmen, two workmen being used for each mould carriage. The pattern plates are fastened to the mould carriages. From the sand reservoir the mould boxes placed on the pattern plates on both sides of the machine are fed in a simple manner by lifting the shutters arranged accordingly.

A machine of somewhat similar dimensions is also in the course of construction for a large foundry in the North of England, and will serve for frame ends for spinning machines.

We are indebted for these particulars to the Simplex Coke Oven and Engineering Company, Limited, London, E.C., who represent the Royal Würtemberg Works, in this country.

Machine Moulding for Large Castings.*

The author, finding that the cost of castings in a new and modernly-equipped foundry was not reduced when compared with the cost of castings obtained with old foundry practice where hand-manipulated jib cranes and other antiquated methods had been in vogue, determined to test the effect of an installation of moulding machines, these to be operated continually and consistently. This decision was the result of a statement made at the 1905 Convention of the National Founders' Association, by Mr. Pessano, as follows :—"Get one or more moulding machines, put them in and make moulds on them. It does not matter whether you actually save money by operating them or not; keep at it and you will soon discover they will be of great value in the more economical management of your foundry."

The installation as suggested by Mr. Pessano was carried out at the firm's works, and worked satisfactorily; but eventually a strike of the Union moulders occurred which resulted in much of the skilled labour being replaced by "handy-men."

"We are unable," says Mr. Bonsall, "to give a

FIG. 1.—GAS ENGINE CYLINDER: BORE 18 IN., STROKE 21 IN.; MOULDING MACHINE JOB. TIME, SKILLED MECHANIC WITH HELPER, NINE HOURS. WEIGHT, 3,650 LBS.

fair comparison of costs and production, for the reason that our old records are based upon steam engine castings alone, while the records since the strike are mostly of gas engine castings, as we were just adding that line when the strike occurred. It is well known that gas engine castings are more expensive to make than steam engine castings.

"We have, however, discovered that in the core shop more and better cores are obtained with one-third of the skilled men formerly employed. This is also true in the foundry, where skilled moulders are employed only for drawing patterns, dressing moulds and setting cores; handy-men shovel and ram the sand. A number of the skilled moulders have not had a rammer in their hands for over two months. We have also discovered that the moulding machine has been of benefit in reducing cost and enabling us to obtain better castings.

"I have photographs of some of the larger castings made since the strike started, with the weight and time of moulding. One of these is a triplex pump housing made by us during the height of the strike. The casting was made by a handy-man who had not been at the business more than six weeks. It was not a moulding machine job, but was made in a drag, cheek and cope flask in the manner in which moulds have been made for many years. The entire mould was put up by this man at a labour cost to us of $13. One year ago we had a Union moulder, who made a mould from the same pattern, in the same way, at a labour cost of $44.20.

"Where we are making our greatest progress, however, is on the moulding machine. The gas engine cylinder of 18-in. bore, 21-in. stroke, and weighing 3,650 lbs., shown in Fig. 1, was rammed on a machine, the pattern drawn by crane, the mould dressed, cores set, and the mould poured the same day. The actual time of the skilled mechanic with his helper was nine hours.

"In another case, a distance piece for a gas engine was made on a moulding machine, the pattern drawn by crane, the mould dressed and core set by a skilled moulder and his helper in nine hours. The weight of the cleaned casting was 3,800 lbs.

"Fig. 2 shows a bed casting made partly on a moulding machine and partly by hand. The machine was not strong enough to ram the mould when the flask was full of sand, so we put all the sand in the flask that the machine would handle and afterwards filled the flask and rammed with a pneumatic rammer. If the machine were strong enough to handle the load we would be able to complete the mould, set the cores, and cast the same day with a skilled moulder and his helper—nine hours—and the help of a handy-man for three hours to assist in dressing the mould. The weight of the casting is 9,300 lbs.

"This is what has been accomplished in four months after the new conditions were established, and I think you will agree that it is fair progress."

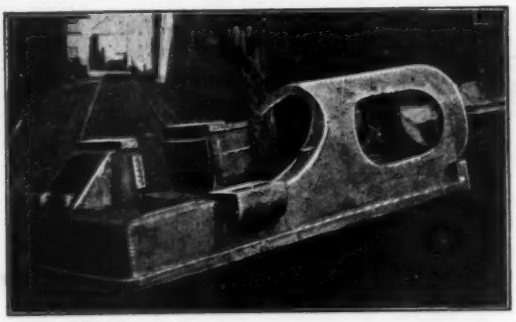


FIG. 2.—GAS ENGINE BED, MADE PARTLY ON MOULDING MACHINE AND RAMMED WITH PNEUMATIC RAMMER. WEIGHT, 9,300 LBS.

* From a Paper read at the Convention of the National Founders' Association, at New York, by C. S. Bonsall.

THE MINERAL OUTPUT OF GREECE.—The mineral output of Greece has been as follows in the last two years :—

	1906. Tons.	1907. Tons.
Lignite	11,580	11,720
Iron ore	680,600	768,860
Manganese ore	10,040	11,140
Manganiferous iron ore ,,	96,380	92,980
Chrome ore	11,530	11,730
Magnesite	61,420	60,250

Foundry Accounting Methods.

By John Doughton.

While the subject of this paper is very comprehensive, covering nearly every element connected with the recording of foundry detail, I shall take up but one phase of the subject, which to my knowledge has received but very little attention. I refer to the proper handling of customers' orders.

Every foundryman is aware of the importance of prompt deliveries in his efforts to secure orders, but often, after an order has been received on the strength of certain promises of delivery, it is neglected or forgotten as far as any attempt to meet the promises are concerned.

In many foundries castings are made without any regard to the order in which they are wanted. When an order is received from a customer it is duly entered and the patterns are placed on a shelf in the

FOUNDRY LAYOUT SHEET

		MOLDER J. Brown				MOLDER J. Smith				MOLD	
MONTH	DAY	ORDER	PAT.	PCS.	HRS.	ORDER	PAT.	PCS.	HRS.	ORDER	PAT.
Nov.	2	4820	B 1	2	10	4821	C-2 C-3	2 2	6 4		
	3										
	4	4820	B 1	2	10	4821	C-2 C-3	2 2	6 4		
	5	4820	B 1	2	10	4821	C-2 C-3	2 2	6 4		
	6										
	7	4820	B 1	2	10	4821	C-2 C-3	2 2	6 4		
	9	4820	B 1	2	10	4821	C-2 C-3	2 2	6 4		
	10										
	11	4820	B 1	2	10	4821	C-3	2	4		

FIG. 1.—FOUNDRY LAY-OUT SHEET.

foundry, and unless the customer has specified when he must have the castings, the patterns may remain on the shelf for almost any length of time, until the customer enquires about them. Now it may be that this same customer has other orders in the foundry. Does that fact have any effect on the order in which the castings will be made? Not at all. If the last pattern is a desirable class of work and calculated to swell the heat or tonnage, in it goes, crowding out castings less desirable for the foundry, but just as necessary to the customer. If the last pattern is of an intricate or otherwise undesirable class of work it is allowed to remain on the shelf together with a lot of other undesirable work that has been allowed to accumulate. Some day the customer enquires for the castings, and then some story is invented to pacify him, and everything is turned upside down in an effort to get the castings out.

This neglected work so accumulates that, when the day of reckoning comes, the foundry has a lot of undesirable work on hand that all customers are calling for at the same time. This is not only a possible condition, but one that has been seen time and again. Very often the failure to make castings to time is blamed on the foreman, though nothing is done to assist him in knowing the order in which they should be made. The greatest harm of this practice is that some customers are receiving castings that they could well wait for, while other customers get practically nothing, and are forced to wait for castings on which they may have allowed sufficient time had the foundry used some discretion and a little diligence in the handling of the order.

Accumulation of Partly Completed Orders.

Another source of annoyance to the foundry, as well as the customer, is the accumulation of old orders that need cleaning up, some only half com-

DAILY WORK SHEET

NOVEMBER 2. 190 8

MOLDER	ORDER	PAT.	PCS.	ORDER	PAT.	
J. Brown	4820	B 1	2			
J. Smith	4821	C-2 C-3	2 2			

FIG. 2.—DAILY WORK SHEET.

pleted, but most of them needing but a few castings to complete the order. The reason for this accumulation of back orders is often found in the lack of proper provision for the discovery and replacing of defective castings. One result of this lack of proper methods is that one day this customer is complaining about neglected orders, and the next day so is some other customer, so that in an effort to keep them all satisfied the foundry is kept in a continuous turmoil, often resulting in bad castings and bad tempers. Another disastrous result is that the customer becomes dissatisfied and is ready to change foundries regardless of price, provided he can be made to feel that his orders will receive better attention.

By the adoption of a simple follow-up system in connection with the orders all this trouble and confusion could be avoided. It must be remembered that labour in the foundry differs from other labour in this, that while the machinist or other workman sees the product of his labour continually and can replace any material found defective or spoiled

* Read before the Philadelphia Foundrymen's Association.

by him, the moulder on the other hand does not see the product of his labour until the end of the day, or it may be after many days. A moulder may complete the moulding on an order, but we are far from being certain that we shall have all the castings. This feature of the foundry business (the inability of the moulder to see the product of his labour and his consequent inability to discover and rectify his mistakes during the progress of his work), is responsible for a great many of the troubles of the foundryman.

There are various order systems in use in the foundry business, probably very few foundries using the same scheme. Some of these systems are models of record keeping, and make good histories of operations in the foundry, but they don't give much assistance toward completing orders with any regard to the customers' interests. By some of them it is necessary for the foundry foreman to act the part of a clerk and to spend a great deal of time going over orders, that might be given to looking after the quality of work being turned out by his men. Nearly all lack any provision for handling the work with any regard to the order in which it is wanted.

A System Necessary.

In looking for a solution of this problem, let us notice for a moment the methods used by an up-to-date purchasing agent for a large plant. When he places an order for any material, the first thing he

TICKLER SHEET

NOVEMBER

DATE	ORDER	ORDER	ORDER	ORDER	ORDER	ORDER	ORDER	
2								
3								
4								
5								
6	4821							
7								
9								
10								
11								
12	4820	4821						
13								

FIG. 3.—PROMISE SHEET.

usually does is to set a date upon which he will look for shipment; he bases this date either on promises made by the shipper or on his expectations of delivery. Now it would be practically impossible for him to go over the purchase orders each day and select those needing attention, so he marks this particular order for attention on a certain date, and when that date comes round he takes out this order and any others that may have been marked for the same date and gives them all the necessary attention. If any require still further attention he fixes the date and again ticks the order as before, allowing none to be put away if uncompleted without being scheduled for future attention. By this method each purchase order is looked after systematically. By precisely the same method we can look after all foundry orders.

I shall not go into details of making out foundry orders, but will describe an automatic follow-up system for following-up orders systematically until every item called for on the order has been delivered. This plan consists of laying out the work as fast as orders are received, assigning each pattern to a certain moulder to be made on a certain day and basing the completion of the order on the amount of work each moulder has ahead of him. Each order is ticked or scheduled to be looked up on certain dates, and all delinquencies are immediately reported and attention given them. In other words, the foundry is operated according to a schedule. By this plan three forms or sheets are required. The first I shall call a foundry lay-out sheet, the second the daily-work sheet, and the third the promise sheet.

The Lay-Out Sheet.

The foundry lay-out sheet, as shown in Fig. 1, is a sheet ruled horizontally and in columns, each column representing a moulder or moulding floor. The spaces between the horizontal lines represent working days. The lines are far enough apart to allow sufficient room for inserting four or five pattern numbers. When an order is received, the foundry order is made out in the usual way, the foreman or other qualified person indicating on each pattern the time required to mould it, the number of pieces he will make each day and the moulder who will make the castings. The order clerk will then mark on the foundry lay-out sheet in the proper columns, according to the name of the moulder, in the first space, the number of the pattern and the number of pieces to be made each day, also the time it will require the moulder to spend each day to make the castings. He will carry this down until the total number of castings required is entered on the sheet, noting the date the order will be completed; this date he marks on the order as a record of when the castings are expected to be completed.

To illustrate:—We receive an order for 20 castings from pattern B-1. The foreman indicates on the pattern that it will require five hours for each casting, and names J. Brown as the moulder; consequently 10 working days must elapse before the order is completed. We turn to the foundry lay-out sheet and in the column allotted to J. Brown we enter the 20 castings. Assuming the order is received on the first day of the month and is the first order, we enter two castings for the first day, two for the next, and so on until the entire order of 20 castings will be completed on the twelfth day, which date we mark on the order.

This illustration is a very simple one, and I will give another not quite so simple. We receive an order for 10 castings C-2 and 20 castings C-3. The foreman says that it will require three hours to make each of the first and two hours for each of the second, and two of each will be made per day. He gives the job to J. Smith, and in the column allotted to Smith we enter two castings C-2 at three hours each, making six hours, and two castings C-3 at two hours each, making four hours, a total of 10 hours. You will note, however, that while the 10 castings, C-2, will be completed on the 6th, the 20 castings, C-3, will not be completed until the 12th. This information is entered on the order opposite each item. You will note also that while this man has a full day's work before him for the first five days, he has only four hours of the next five days, so

that, as the orders come in, we must fill in these days with work he is capable of handling.

The lay-out sheet when filled in as the orders are received will show, first, what work is assigned to each moulder, and the probable length of time it will take him to complete it; and, second, by referring to any certain date we can see what work is laid out for that day.

The Daily Work Sheet.

The next step is to let the moulder know in a convenient way what he is to make. For this purpose we use the daily work-sheet, as shown in Fig. 2. This is a sheet ruled horizontally, each space representing a moulder or moulding floor. To the left is entered the name of the moulder, and opposite his name is entered the patterns he is to work on and the number of pieces he is to make that particular day. This is made up from the foundry lay-out sheet, and should be made up the day before, so as to be ready for the moulder in the morning.

Certain modifications of this plan might be used effectively, eliminating certain features in some cases and adding in other cases as necessity required. I can conceive of a plan where the pay-roll and cost system could be handled in connection with the system here-outlined to good advantage.

There are many subjects connected with the handling of the orders that I have not touched upon, as, for instance, the handling of patterns, the handling of castings from the moulding floor to the customer, the discovery of defective castings, simple accounting methods, and many other subjects that suggest themselves. These all go toward making an effective system for giving prompt and satisfactory service. The difficulty with some systems is the subserviency of the foundry to the system, whereas the reverse should prevail, and the system be made to serve the needs of the foundry and the interests of its customers.

Special Ferro-Alloys.

British Foundrymen's Association: Sheffield Branch.

An interesting paper on "Special Ferro-alloys, Available for Use in the Foundry," was given by Mr. E. Houghton, Chesterfield, to the members of the Sheffield Technical School on December 12. Mr. H. Pilkington, the Branch President, was in the chair.

The paper was substantially the same as the one on the same subject read by the author before the Annual Convention of the British Foundrymen's Association in 1907. The full paper, with tables giving analyses of various alloys, will be found in our issue of September, 1907.

The manufacture of ferro-alloys on a commercial scale, Mr. Houghton pointed out, is only of comparatively recent date. The use of alloys has extended till at the present time their name is legion, and their application in steel and iron founding most important. Until quite recently the only method of producing the ferro-alloys was by means of the blast furnace or the crucible. Now, however, since the introduction of the electric smelting furnace and its success commercially in the production of rich ferro-alloys, a great variety of them are obtainable at a comparatively moderate price, and some which to-day are of common occurrence, were but a short time ago merely curiosities. The blast-furnace alloys are few in number, though very important, and comprise ferro-manganese, spiegel, silicon-spiegel, ferro-silicon, ferro-chrome, and ferro-phosphorus. Other alloys important to foundrymen are ferro-aluminium, ferro-titanium, and mixed alloys of these elements. The blast-furnace products would generally, he thought, be the cheaper per ton, or even per unit of the valuable element, than the electrical product, but their chief drawback, especially in the steel works, had been the high percentage of carbon. With the electrical furnace product this element can be kept remarkably low, whilst, generally speaking, the highest and purest grades can be readily obtained.

The object of the use of ferro-alloys in the foundry is:—(1) To act as deoxidisers and desulphurisers, the added element remaining only in small quantities in the finished casting; (2) to alter the composition of the casting and so to gain control of the condition of the carbon and the mechanical properties of the casting. The most important and abundant of the alloys of iron are ferro-manganese and spiegel. His conclusion in regard to the addition of alloys in general to cast iron was that much greater benefit would be secured by addition after melting.

Mr. Houghton considered that there should be a use for silicon-spiegel in the iron foundry, as both manganese and silicon are deoxidisers of considerable power. Ferro-chrome is an alloy that if it is to be used at all in the foundry would have to be used very sparingly, and for particular work only, mainly on account of its cost. The only possible use of ferro-phosphorus in the iron-foundry would be in the production of very fine and thin castings, artistic work where excellency of detail was of paramount importance, and strength secondary.

Discussion.

In the interesting discussion that followed, the CHAIRMAN observed that there was no chilling material in the world superior to our cold blast pig-iron made from clay band ironstone. In this country we endeavoured to make our castings to suit the ultimate service they would have to perform. Apparently in America they were made with a view to easy machining instead of for their subsequent wearing qualities.

THE public examination of Mr. T. R. Hill, Bow Foundry, Bow, E., and Enfield, N., who traded under the style of Henry Edie & Company, was concluded in London, recently. The statement of affairs showed gross liabilities amounting to £16,216 7s. 8d., of which £8,188 15s. 2d. was expected to rank, and assets £674 4s. 11d. The bankrupt attributed his insolvency to heavy bad debts incurred three years ago, and to consequent loss of credit.

Brass Founding.

By Professor Turner.

British Foundrymen's Association: Birmingham Branch.

A meeting of the Birmingham Branch of the British Foundrymen's Association was held at the Municipal Technical School, on Saturday, November 28, and the members of the Birmingham Metallurgical Society attended by special invitation to hear a lecture by Professor T. Turner, M.Sc., on "Brass Founding." Mr. Robert Buchanan (President) was in the chair, and there was a large attendance of members of both organisations.

Professor Turner commenced by describing what, to his mind, was the ideal of a brass foundry. Such an establishment, he said, should be arranged as far as possible on a rectangular plan, and all on the ground floor. The several departments should be so arranged as to obviate the passing backwards and forwards of material while in course of manufacture; the raw material should go in at one point and go forward as the different processes were carried out until the finished product came out without having retraced its journey at any stage. The brass-foundries in Birmingham, however, as far as he was acquainted with them, in very few cases even approached this ideal. Many brassfounders in and around Birmingham would confess that their works were never designed with any general idea relative to the present conditions of manufacture; in fact, if they had been so designed they would have been very different from what they are. It would have been better and more economical in the long run if these places had not been allowed to "grow," but instead of being extended, had been pruned and rebuilt.

The lecturer described the series of processes involved in producing finished brass castings, and the manner in which they would succeed each other in a well-ordered establishment, emphasising as he has done on many previous occasions the importance of proper washing accommodation. He exhibited illustrations, both plans and views, of typical modern brass foundries in Great Britain. The first views shown dealt with the foundry of Vickers, Son & Maxim, Barrow-in-Furness. Professor Turner called attention to the excellent provision of cranes, including the central crane, to which ran the line of rails from outside, and which commanded the whole of the different departments, with the supplementary cranes stationed at convenient points in other parts of the works area. The lecturer illustrated and described not only the crucible furnaces, but also the furnaces for dealing with large castings weighing several tons, such as propellers, when it was obviously inconvenient to deal with the metal by means of crucibles. Views were next shown of the brass foundries of the Westinghouse Company, Limited, and of Armstrong, Whitworth & Company, and the lecturer pointed out in passing the advantages claimed for double-row furnaces. Having again impressed upon his hearers the importance of starting with a fairly high ideal of the general arrangements of their work, he said the next thing to be considered was the selection of metal. Of course, the fundamental in each of the series of alloys which, as brassfounders or bronze-founders, they had to deal with, was copper. They did not choose, as a rule, electrolytic copper—though that might sometimes be used, nor the same kind of copper that would be used for a tough finished article in copper, such as wire. The copper generally preferred was what they usually called "best selected," containing something like 99.75 per cent. of metallic copper, the rest being impurities. Having described the rolling test for the copper, Professor Turner came to the selection of the zinc. One of the commonest impurities in zinc, he pointed out, is lead, and one must be careful not to have too much of it. But it was not at all difficult to get zinc with only a minute trace of lead. For some common purposes there was no advantage in having the zinc extremely pure, and there were many cases in which no trouble would be experienced with zinc containing ½ to 1 per cent. of lead. Roughly, if they had two parts of copper to one part of zinc, and the copper itself contained no lead at all, they could always permit 0.35 per cent. of lead in the zinc without injury to the brass, while for such things as taps a great deal more lead in the zinc was used. For instance, for common red taps, the percentage might be 7, 8, or 10 per cent. For best castings 0.35 per cent., or at the utmost 1 per cent., was the maximum allowable.

Dealing with bronze alloys, the lecturer said that there should be no difficulty in getting pure tin if they had the money to buy it. (Laughter.) The "Lamb and Flag" brand, and other sufficiently refined brands, however, commanded high prices, and nowadays there was a disposition to experiment largely with other bronze alloys. Aluminium-bronze came in as a special alloy about 30 years ago, and wonderful things were anticipated of it, but it had not met with approval to the extent that was then expected, one reason being that this bronze did not resist corrosion very well. He believed, however, that there had lately been a little advance and expansion in regard to the aluminium class of bronzes. Dealing with the question of lead in alloys generally, he pointed out that though in some cases lead was merely an adulteration, in many cases it was introduced with a purpose, especially where the metal had to be worked. It was found that lead made the brass hold up to the tool better.

Among the special additions to bronze alloys was phosphorus, which was added either as phosphor-tin or phosphor-copper, and which gave not only greater density, but higher tensile strength, and a higher limit of elasticity in proportion to the tensile strength. Such metals had important wearing qualities, and though somewhat more expensive they had for certain limited purposes a very great advantage.

Dealing with the proportions of the different metals in mixing, Professor Turner put on the screen equilibrium diagrams of the copper and zinc, and copper and tin systems of alloys, and explained the theories which govern the effect of the properties of alloys of different combinations of the alpha, beta, and gamma constituents. He pointed out how, in contra-distinction to iron and steel gradual cooling of copper alloys tended to hardness. Among the other illustrations shown were some of elaborate Japanese castings in bronze, including views of temples and other large structures which had been cast *in situ*.

On the subject of crucibles and furnaces, Professor

Turner remarked that there appeared to him to be in the Birmingham brass foundries a great waste of fuel owing to the large space round the crucibles. In many cases the furnaces were square, while the crucibles were round, but in addition to this apparent waste of fire space crucibles were often used in furnaces which were made for larger ones. Supposing they had a furnace constructed for an 85-lb. pot, then it would be an expensive one to use for a 60-lb. pot, and ruination for a 35-lb. He considered that any space round the crucible in the furnace beyond 6 in. was uneconomical. He dwelt upon the importance of cranes for lifting the crucibles of large size, and referred to the tilting furnaces used largely in America, but which were very little used in England. He believed that at Maldon's they were being used and were working very nicely. In his illustrations of brass-founding at Rainsford & Lynes' Works, Mr. Turner pointed out how admirably the arrangements worked for carrying off the fumes, as illustrated by the clearness of the photographs of the casting operations.

Mr. A. H. Hiorns (President of the Birmingham Metallurgical Society) opened the discusion. He remarked that the explanation given by the lecturer with regard to the method of quenching and the equilibrium diagram enabled them to understand clearly why the ancients were so successful in hardening bronze as to be able to make from it razors and swords and other implements.

Mr. W. B. Parker (Rugby) said that Professor Turner had mentioned copper with a purity of 99.75, but he himself had found it very difficult to get any guaranteed over 99.5 per cent. Electrolytic copper was coming more and more into use as the main material for foundry work. In America hardly any of the "best selected" was used, and nearly all copper used by American brassfounders was electrolytic. He should like to know something about the percentage of antimony in tin. In buying a tin they were often told by the sellers with regard to antimony: "Oh, it is just the impurities in the metal." But they knew that if the tin were selected carefully there would be no antimony. He would like to ask what crucible Professor Turner recommended for manganese alloys.

Mr. F. M. Thomas observed that although brassfounding was a staple trade in Birmingham, very few papers or lectures were given on the subject. Although the cooling of brass and gun-metal produced a different effect from that which resulted from cooling steel, there were points of similarity in the treatment of the two alloys. For example, to reduce blow-holes and secure greater homogeneity of the metals the same deoxidising agents were used. A very small percentage of manganese introduced into brass or gun-metal had a marked beneficial effect. Not only did it tend to remove blow-holes and increase the soundness, but it also imparted strength to the castings. In brass or gun-metal the manganese should be introduced as cupro-manganese, about 80 per cent. copper and 20 per cent. manganese, and the quantity to be used depended upon the class of castings and the quality of the metal. Usually gun-metal would require rather less than brass, and if scrap metal were being re-melted a rather larger quantity of manganese should be added to act as a flux—for best gun-metal 88 Cu, 10 Mn, 2 Zn. The addition of 4 ozs. of Cu Mn alloy to 100 lbs. of metal would be sufficient, whilst for re-melted, ingot or scrap up to 0.5 per cent. could be used. This would increase the tensile strength several tons per square inch. In the case of gun-metal, which would ordinarily have about 12 to 14 tons tensile per square inch, this figure would be raised to about 16 tons, and the metal would be only very slightly harder to machine. Electrolytic or "best selected" copper was used for making tubes and sheets; but for ordinary castings tough copper was quite satisfactory and cheaper to use. For small fittings and cocks a much cheaper mixture would suffice than for important engine castings. With regard to crucibles, the "life" depended upon the class of work done and the quality of the coke used. The temperature of the furnace varied considerably for different classes of work, but a good plumbago pot ought to give thirty heats on best work and more on common work. There were obvious disadvantages in using mechanical brass furnaces where pots of 200 lbs. capacity and upwards were employed. If the pots burst it was a difficult matter to extricate the heavy conglomerate mass of metal and cinders from the furnace, which would also probably want relining, and much delay and expense would thereby be incurred.

Mr. F. J. Cook (President of the National Association of British Foundrymen) said that one point in the lecture that struck him as very good was the advice that the area of the furnace should not be too great for the pot. He had often noticed in brass-foundry shops that square furnaces were used instead of the round ones, which had been shown on the screen, and that he thought meant a waste of material and fuel. Although he had not had actual experience with mechanical furnaces, he had seen some of them in use, and he believed they had not come up to expectations. The average life of a 60- to 80-lb. pot was about thirty heats. When one of these special furnaces was put in with a 200-lb. pot, the average life was seven heats. At the end of these heats the furnace had to be rebuilt, which was a very large expense, and the contrivance had to be rejected. They ought to be very careful about accepting all that was told them by those who had these patent furnaces to sell. He did not say they were all bad, but he had seen a great many, and he had not yet come across a good one.

Mr. Spittle (Birmingham) said that the point with regard to grate area was very important. In practice he thought it would be found that even 6 in. was very much too great a space. One could very easily melt 150 lbs. of brass with a distance of not more than 2 in. from the pot to the wall of the furnace; with a distance of 4 in. one got a great deal more than three times as much coke as was needed, and, of course, a round furnace was superior to a square one in having no corners to fill with coke.

Mr. Conday said that from his experience he thought 2 in. would be a very tight fit. The coke would be constantly jamming round the crucible, and the melting would take a much longer time. In reply to the President, the speaker said that the space suggested by Professor Turner, about 6 in., would, in his opinion, be best. He thought, too, that the square furnace was preferable as giving ample room for the tongs to go down. But in that case he agreed with Mr. Spittle that 2 in. might be ample for giving the necessary heat.

Mr. Reason said that in the majority of Birmingham foundries he thought the furnaces were built square. Perhaps for a 60-lb. pot a space of 2½ in. would serve, but he would not recommend so small a space as 2 in., as there would be hardly room to get the tongs down to get the pot out safely, and with so small a space it would take, he thought, a long time to get sufficient heat. With large-sized pots, say 150 to 300 lbs., his experience was that to get the pots out in anything like reasonable time they would want a thickness of 3 or 4 in. of coke.

The President expressed agreement with all that had been said as to the value of the lecture. It must have struck them all when they saw the views of those splendid castings that the Japanese had made

that that nation had very little to learn from the West with regard to bronze-founding. Casting large objects *in situ* was not at all unknown in England. He had been looking up the subject of bell casting, and he believed in one case a cathedral bell was actually cast in the cathedral itself. One thing that no other speaker had referred to was the custom which prevailed among brassmoulders, though he though' not among ironmoulders, of dancing on the moulds. He had often tried to puzzle out why that should be done, but had not been able to discover the principle of it. Yet he had reason to believe there was something in it. A man who went out to manage a very large brass foundry in America started the men dancing on the moulds as he had been used to do at home. This caused very great amusement, not only in the foundry, but all over the town. But when the Americans saw the castings it was not long before all the foundrymen in that town were "dancing the moulds." On behalf of the Foundrymen's Association and the Metallurgical Society, he conveyed very hearty thanks to Professor Turner for his lecture.

Professor Turner, in reply, said that he believed that in America they had not "best selected" copper available, and were obliged to use electrolytic, which was as good, in fact, possibly better, for all ordinary purposes, if they could get it as cheaply, but it depended upon the kind of work. There are some kinds of work for which it would not pay to use it, but if they were going to work the metal it was best to have pure material. He had to examine a large quantity of Cornish tin ten or a dozen years ago, and found scarcely a trace of antimony. If antimony were found in the solder, the first thing he should inquire about would be what scrap was used. A very small quantity of type metal, for instance, would give them antimony. With regard to manganese bronze, the crucibles ordinarily used were of a good mixture of Stourbridge fireclay and charcoal. They had had an interesting discussion with regard to the thickness of the coke round the pots. It depended, as several speakers had pointed out, partly upon whether they had a round or a square furnace. Then he had in view partly the fact that sometimes in practice it was advisable to change the size of the crucible. The question was, "Within what limits can one change crucibles of different sizes with economy?" Supposing that in changing the crucible they got more than 6 in. of space, it would then be cheaper to change the furnace.

A Revolving Drum Sand-Blast Machine.

Sand-blast machines of the revolving drum type have many advantages over the rotating table type, because in the drum machines the sand blast not only operates on top of the parts being cleaned, but passes through any holes in them to the pieces below, and thus the whole force of the blast is utilised.

Small castings are much more effectively cleaned by sand-blast than in a tumbling barrel, and the edges and fine outlines, which are often injured by the rapid rotation of a tumbling barrel, remain quite sharp after treatment in a sand-blast drum.

A common practice with machines of the revolving drum type is to spray a stream of sand from one or more nozzles, which nozzles move backwards and forwards as the drum revolves, and as a consequence some of the castings exposed get much more intense treatment than others. Figs. 1 and 2 depict such nozzles in operation. The machine shown in the illustration (Fig. 4) is provided with a patented slot-jet (Fig. 3), fixed axially, so that the rotation of the drum round the jet is unhindered, and the castings, as they are brought under the action of the blast, are operated on equally over the whole width of the drum, the jet of sand being even throughout the whole width. Owing to the rotation of the drum, the castings always assume an inclined position, the angle of which varies according to their size, and since the action of the blast is most efficient when it strikes the castings in a direction perpendicular to them, it is essential for efficiency that the jet

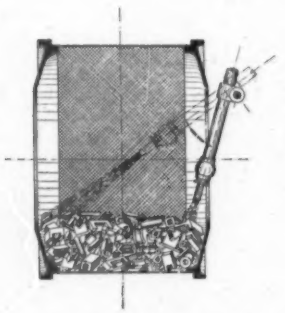


Fig. 1.

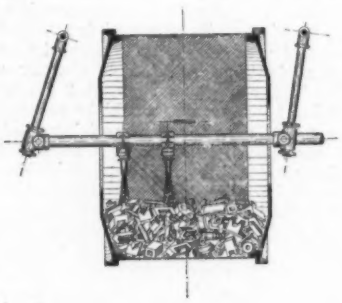


Fig. 2.

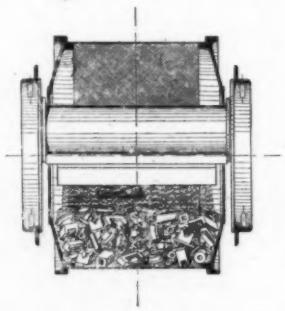


Fig. 3.

Nozzles for Sand-Blast Machines.

should be adjustable. This adjustability is a feature of the machine shown. Another advantage arising from the fixed slot-jet is that there are no movable air and sand pipes, and no hose couplings or joints, so that there are no opportunities for leakage.

This machine is designed so that the air only meets the sand at a point near where it enters the jet. A pressure of 15 to 16 ozs. gives the best results, and the machine can be operated at a low expenditure of power by a positive pressure blower.

In operating the machine, the sand which has been projected against the castings falls through the perforated casing of the drum on to a wire screen, which collects foreign matter, such as moulding pins, etc., the sand passing through it to a worm conveyor, whence it is carried back by means of an elevator to the sand hopper, and then again distributed by a small worm over the whole length of the blast jet. A continuous and automatic circulation of the sand is thereby obtained, and the delivery of the sand to the blast-jet is kept even, and is independent of the quantity fed to the hopper by the elevator. The dust is removed by a fan exhauster connected to the dust outlets of the machine. An interposed centrifugal dust collector can be employed to separate sand carried along by the air current, and to return it automatically to the machine.

The machine is suitable for cleaning and removing the skin from small castings of either steel, iron, or other metals, and also for cleaning stampings and forgings. Cores may be blasted right out of hollow castings, such as steam fittings, without injuring the cored parts.

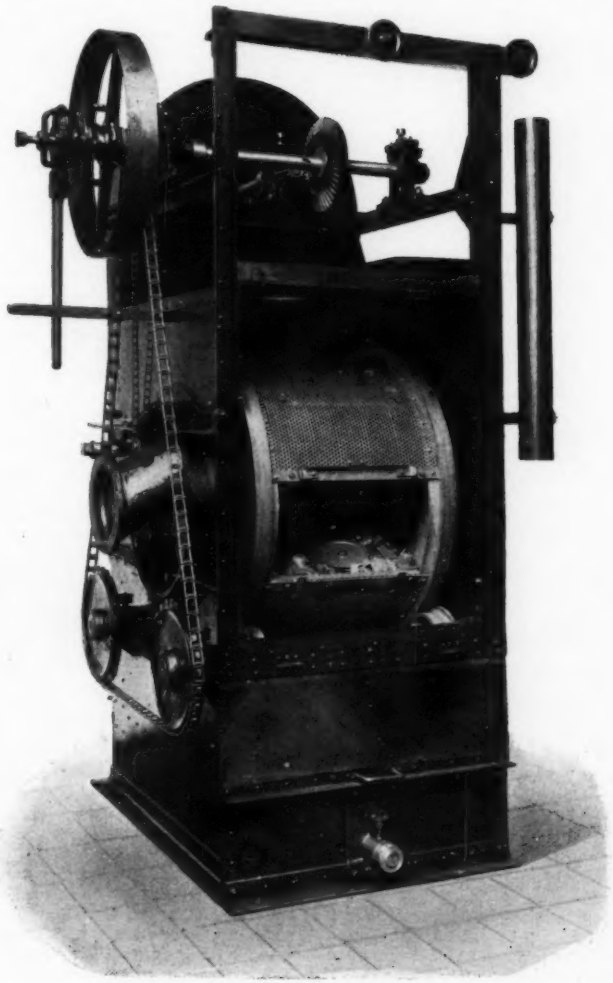


FIG. 4.—REVOLVING DRUM SAND-BLAST MACHINE.

The makers of the apparatus are Messrs. J. W. Jackman & Company, Limited, Caxton House, Westminster.

MR. F. A. SMITH, of 45, Sackpool Road, Southville, Bristol, who has been the Carron Company's representative in Bristol and district for many years, has now been appointed to the West of England section in addition to Bristol, in place of Mr. F. C. Hemmins, who has ceased to represent the company.

Moulding Machines for Stove Foundries.

Report on Labour-Saving Machinery.

At the annual meeting of the Stove Founders' National Defence Association, held in New York, May 12, 1908, a Committee was appointed to investigate the question of all machines for foundry use. The Committee, consisting of five stove manufacturers, entered upon its labours at once, with the object of securing for the members of the Association such information about labour-saving machinery and devices as would enable all to estimate for themselves the possibilities of economies to be thus secured. The Committee visited many places and witnessed the operations of machines for stove foundry work, comprising moulding machines, polishing machinery, facing machines, stove blacking machinery, and sand cutting, sand mixing, and sand milling machinery. The report of the Committee, which was submitted to the Association at a special meeting held in New York, November 17 and 18, gives much valuable information, especially with regard to moulding machines.

Besides stove manufacturers, the Committee interviewed other foundrymen, including a number of moulding machine manufacturers, and visited their plants.

Moulding Machines.

The Committee's observations lead them to the conclusion that there are few, if any, stove patterns that cannot be made on a machine or some form of device or rig that reduces the requirements for moulding skill to the point where a labourer of ordinary intelligence may be taught in a short time to produce castings in equal or increased quantity and of equal or better quality than are now made by the average stove-plate moulder, and nearer to pattern weight. The statement dealing with the education of the machine operator includes consideration of the items of ramming, pattern drawing, finishing and pouring off, and is based on actual experience. It becomes then mainly a question of the choice of apparatus that will do the work successfully. The usual considerations that will guide in the selection of apparatus are size, weight, and depth of pattern; number of castings to be made; adaptability of apparatus to making other patterns; its simplicity, reliability, and output. For such work as is ordinarily made on the bench a choice of widest variety is offered, running from the simple squeezer to the complicated automatic machines.

Simple Squeezers.—In squeezers the inherent time-saving operation is the pressing of the mould. The maximum output may be gained by the use of a double-faced match plate and pneumatic rapper. This outfit, simple and inexpensive as it is, may effect a saving over bench work of one-fifth to one-third. The Committee are also advised by the manufacturers that stripper jobs may be made on squeezers, and the change from match plate to stripper effected in two minutes.

Squeezer with Duplex Match Plate.—This machine is an elaboration of the simple squeezer, and includes a number of special features entitled to separate notice. The distinctive feature, and the one which mainly accounts for the large output that may be secured from this machine, is the placing side by side of both cope and drag, which are filled with sand and tucked, while the moulder has his shovel in hand and before he lays it down. Examples of large outputs are 250 10 by 19 in. moulds in less than seven hours' moulding time, and in the same time 220 moulds of 8-in. covers, two in a mould. It is claimed that the attachment of a pneumatic rapper increases the capacity of this machine, and it may be so equipped. The examples of a day's work, named above, however, were produced without the pneumatic rapper. In places where these machines are in use it is regarded as good practice to match plate for this machine any patterns of which 1,000 or more moulds per year are to be made.

Stripping Plate Machine.—The Committee found some application of small work in this type of machine, but in most cases it seemed that a more favourable result could be secured with small work in applying it to the squeezer type just named. The stripping plate machine finds a more logical and profitable application for larger work, with barrel flasks where hand-ramming is used. Reference has already been made to stripping plate jobs on squeezers. The Committee observed very few of these machines in use under what seemed to them the most favourable conditions, and hence are unable to state from their own observation what may be expected of them. There appears no reason, however, why, together with the simple squeezer, this machine should not find a more extended introduction into stove shops. They have the advantage that the pattern rigging best adapted to the machines is likewise best adapted to the bench.

Automatic Machines.—The full automatic machine in perfect order is probably capable of producing moulds at less cost than any other type of machine. It has the advantage of being able to produce in a very short time a very large number of castings from one set of patterns. The Committee had no opportunity of noting carefully the range of work of which such machines are capable, but since the mould is automatically filled with sand and the operator has no opportunity to tuck the mould, they regard it as not likely that this machine can be depended upon outside of the range of flat or shallow work. It is, furthermore, more apt to get out of order than the non-automatic machines.

Multiple Moulding Machines.—The machine used in multiple moulding is a power ramming machine. This method has so far been applied only to heavy work of small area. Since the impress of both the cope and the drag pattern are rammed into the same half-flask at the same time, this forms a very quick method of moulding. It has the further advantage of requiring much less floor space, since five complete moulds, and sometimes more, rest in the space of one. With an air hoist operating over the moulding floor, a bull ladle brought to the floor on a trolley is used to pour off, and the moulds are shaken out by the hoist. It becomes easy in this manner to handle cheaply and easily a large amount of sand and iron.

Hand Ramming Stripping Plate Machines.—The Committee observed this type of machine in use on work such as fire-pots, oven burners for gas ranges, boiler sections, etc. It seems to find its best application on the large work such as boiler sections. It also has its application on deeper work.

Hand Ramming Rockover Drop Table Machines.—This type of machine seems to be adapted to any flat work requiring barred flasks. It was seen in use for making end shelves, gas stove tops, etc. This machine is also designed for making work of considerable depth. The Committee found fire-pots being made; the cope on a rockover drop table machine, the drag on a stripping plate machine.

Gravity Moulding Machine.—This is a patented machine and method, and was under observation only in demonstration and not seen in operation in any shop. In other lines of work it is said to be giving good satisfaction and giving a large output.

Match Plate and Hinge Device.—Two hinge devices of this character came under observation, one being used in connection with iron flasks, the other being used in connection with the ordinary flask now in use in any foundry. The latter consists of a simple hinge which may be attached to any wooden flask, and it is so constructed that the two parts of the flask with the match plate between them may be rammed up together, or, in the case of large flasks, the match plate supported by a frame during the ramming of the first half, and first the cope rolled off on the hinge, then the match plate rolled off and the cope rolled back on again in the hinge and the flask thus closed. The Committee observed that with this latest simple improvement in moulding methods labourers were able to do the work formerly done by skilled journeymen.

Deep Work.—For this work both the hand-ramming stripping plate and rockover drop machines find application, as noted previously. The power jar or jolt ramming machine is the type particularly designed for work in which the ramming is a large factor, such as fire-pots, etc. It is likewise said to be successfully used for steam and hot water boiler sections.

The foot power jolt ramming and pressing machine seems to be very well adapted to making deep work of small size in snap flasks. It is similar to the squeezer type with duplex match plates and pattern drawing mechanism above mentioned. In addition to the pressing mechanism, it has a foot jarring mechanism for ramming which makes it possible to ram deep work successfully, and does away with the necessity for tucking.

General Conclusions.

Briefly, the conclusions formed by the Committee after the study of moulding machines in the stove industry are as follows:—

1. That the stove industry is far behind others in the employment of labour-saving machinery and devices.

2. Moulding machines are successfully used in some stove foundries to reduce moulding cost.

3. Those institutions that are making the most use of the machines are also those that are most rapidly adding to their equipment.

4. The best results in the use of the machine were observed in open shops.

5. Best results were seen to be obtained from breaking in an unskilled operator.

6. There is at least a reasonable hope that the necessity for printing back may be done away with where exhaust mills are in use.

7. That all stove patterns can be moulded with some form of machine or device already in use.

8. It is merely a question of the cost of patterns for the machine and the number of pieces to be made whether or not it will pay to mould the piece in question by machine. For bench work the number so required to be made to make machine moulding profitable is about 1,000 moulds for the more expensive pattern rig and a correspondingly small number for the less expensive rig.

9. It requires a smaller number of large pieces to be made to pay for new pattern equipment, since the saving per piece is larger in proportion to cost of pattern than in the case of small pieces.

10. Through the use of these practically indestructible pattern plates in place of loose iron patterns, the cost of maintaining patterns in repair is reduced and the necessity of preserving and caring for duplicate sets of patterns in wood or iron is obviated.

11. The best results may be obtained from a system of specialised labour, which allows the machine operator to devote himself exclusively to moulding and pouring. Carrying iron, shifting weights and strippers, shaking out, and, if possible, cutting over sand should be performed by common labour—machine operators to be. This suggests the employment of surface or overhead carriers as labour-saving devices.

12. A saving of about 5 per cent. of iron in machine over hand-moulded castings seems not unreasonable to expect. An incidental effect on factory economy is suggested by the report of a case where a reduction in the cost of grinding and mounting small cast ranges was secured, after the castings were moulded by machinery.

13. The manner, most apt to be successful, of making moulding machine installation, is:—

First, determine that you have enough patterns of which the necessary number of moulds are to be made to keep a number of machines busy.

Second, see that your organisation, from manager to machine operator, is prepared to back the machine with intelligence, energy, and enthusiasm.

Third, select carefully the make of machine best suited to your work. Start with not less than two machines and let all be of the same make; this simplifies matters, gives an opportunity to make competition between operators, and avoids concentrating on the one man all adverse criticism of influence. Employ every means to shield operators from sight and influence of the rest of the shop.

Fourth, after having begun right, see that your installation continues to work right.

14. The increased use of moulding machinery will result in increased standardisation of parts and reduction in the variety of patterns.

THE PARKER FOUNDRY COMPANY, LIMITED, of Derby, have appointed Messrs. Umney & Peckett, of 46, King William Street, London, E.C., to represent them in London and district.

PLUGGING HOLES IN ALUMINIUM CASTINGS.—A cement for plugging holes in aluminium castings has recently been placed on the market in Belgium. The material is termed "Antonal" metallic cement, and has the colour of aluminium. The cement, which apparently contains aluminium powder, is mixed with water in the proportion of six parts of cement to one of water until a paste is produced. This is pressed into the defective parts to be plugged, and is allowed to set. The surplus material is removed with a knife or chisel, and after 48 hours, when the mass has become quite hard, the surface is polished with emery cloth. The cement has the same colour as the casting, and is stated to resist acids and oils and to be capable of standing considerable pressure. Gasoline, also, is said to have no effect on it. The use of the cement is, of course, confined to cases where the defect does not impair the strength of the casting.

The National Founders' Association.

The Twelfth Annual Convention.

The twelfth annual Convention of the National Founders' Association, held at the Hotel Astor, New York, November 18 and 19, differed from most of its predecessors in the absence of any protracted discussion of questions of association policy or of shop management. The Convention was marked by the resignation of President O. P. Briggs, who, as commissioner for two years and then as President for three years, has been so large a constructive and administrative factor in the affairs of the organisation. His successor, Henry A. Carpenter, Providence, R.I., has long been a popular and influential officer of the Association.

President Briggs, in the introductory portion of his report, referred to the depression from which the foundry interest, in common with all business, had suffered in the past year. The entire absence of labour difficulties affecting members of the Association in the past season he regarded as a phenomenal record.

Commissioner A. E. McClintock devoted the major part of his report to a discussion of the Association's work in extending the use of moulding machines, operated for the most part by handy men. The obligation of training a full quota of apprentices was urged by the commissioner, investigation having shown that many foundries do not educate 10 per cent. of the number of apprentices whose employment is practicable in their particular work. The great majority of the shops of the Association are now open or non-Union, and the apprentices therein are receiving an education in moulding far beyond anything previously available. Not only are foundrymen giving attention to the boys, but the boys are showing more interest than ever in the work. Care in the selection of handy men and apprentices was suggested, so that boys and men of good physical and moral fibre might be secured who would elevate the standard of the shop.

In reply to a question concerning the use of the premium system in the foundry, several members said that they were employing it with success.

Mr. L. L. Anthes, President of the American Foundrymen's Asociation, who opened the second day's session, recalled that the National Founders' Association was really an off-shoot of the American Foundrymen's Association, though the two organisations had taken different lines of operation, the latter being concerned entirely with educational work and the improvement of practice. He referred to the advance made in recent years toward greater certainty in foundry results in consequence of the application of scientific methods. The use of pig-iron analysis in the making of foundry mixtures was chief of these advances. What remained was to do the same kind of work for sand and coke, and to extend generally the application of science in the foundry. He urged the necessity of establishing a laboratory and bureau for analytical work in foundry lines and the standardisation of material, the results of such experimentation to be available generally to associated foundrymen. The American Foundrymen's Association and the American Brass Founders' Association had already conferred about the matter through their Executive Committees. He suggested the appointment of a committee of three by the National Founders' Association to co-operate in the movement.

Dr. Richard Moldenke, Secretary of the American Foundrymen's Association, said he believed the establishment of a bureau to fix standards of material and practice would greatly reduce the loss of castings. The motion for a committee of three to co-operate in the movement suggested was carried, and the committee will be appointed in due time by the incoming President of the Association.

A resolution was introduced requesting the incoming Administrative Council to make use of the present executive force of the Association in the furtherance of the use of moulding machines in the foundries of the membership. It was pointed out in the discussion of this resolution that when strikes occur the effort always is to introduce moulding machines, and often much time is spent in investigating their possibilities and in experimentation. Instead of losing this time now devoted to these preliminaries it was argued that a good many questions relating to the moulding machine could be threshed out by the staff of the Association, and data obtained which would be available for the guidance of members contemplating the use of machines. The resolution was adopted, and the matter was left entirely in the hands of the new Administrative Council.

Mr. H. A. Carpenter, Providence, R.I., was elected President in succession to Mr. Briggs, and the latter gentleman was elected Vice-President.

A Zinc-Aluminium-Copper Alloy for Use in Metal Moulds. — An alloy of zinc, aluminium, and copper has been patented by Mr. W. J. Leddell, of Summit, N.J., U.S.A., for use in making castings in metal moulds to compete with brass castings. Owing to the fact that they require little, if any, machining, the advantage of castings made in accurately-machined moulds over brass castings made in sand is obvious. Again, the cheapness of the mixture is greatly in its favour.

The mixture which has been patented is as follows :—

Zinc...	90 per cent. or 90 lbs.
Aluminium	5 per cent. or 5 lbs.
Copper	5 per cent. or 5 lbs.

In cases where a harder alloy is desired the proportions of aluminium and copper are increased :—

Zinc...	87.50 per cent. or 87½ lbs.
Aluminium	6.25 per cent. or 6¼ lbs.
Copper	6.25 per cent. or 6¼ lbs.

The advantages of these alloys are said to be the low shrinkage, ability to run into metal moulds with sharpness, and freedom from crystallisation. In addition, the cheapness is an important factor. The mixtures are recommended by the inventor for making nipples, cocks, and other plumbers' fixtures, and also for journal bearings and a large variety of small metal castings.

In cases where thin shapes are to be cast, the inventor advocates the use of a small amount of cadmium in the mixture, but he says that ½ per cent. or less is all that is required.

The "Foundry Trade Journal" Bookshelf.

Alloys.

By A. Humboldt Sexton, F.I.C., etc. Manchester: The Scientific Publishing Company.

For this addition to the library of metallurgical literature we note that the author declines to apologise. With that sentiment we are in entire agreement, for if there is a branch of the study of metals about which existing information is meagre it is undoubtedly that of Alloys. Special thanks are therefore due to the small but select band of authors who have provided the few text-books—of a strictly unpretentious order—that are extant. Among this band a place of honour must certainly be assigned to Mr. Sexton, whose latest volume displays in abundance those qualities of careful research, breadth of view and clearness of style which we have learned to associate with his work. In this book he attempts no complete and comprehensive survey of the subject of alloys; he contents himself with providing a brief account of the advances recently made in the study of the subject, indicating the lines on which its investigation is still going on, and presenting information of a practical character to makers and users of alloys. An important omission in the book is to be noted. The number and importance of the alloys of iron are such that the author, wisely we think, has decided that a separate volume would be necessary to do justice to them, and has therefore omitted them altogether from the present work. Apart from those of iron and steel, the author enumerates nine groups of alloys, viz.:—Brasses (copper and zinc), bronzes (copper and tin), machinery brasses or bronzes (copper with tin and zinc), aluminium alloys, white alloys, light or fusible alloys, nickel alloys, precious metal alloys, and amalgams or mercury alloys. As to each of these the author has much to say of a useful and informing character. Tables and diagrams relative to the physical properties of the various alloys are numerous, while a series of well-executed micrographs adds to the interest and value of the work.

Guide Pratique Du Chimiste Metallurgiste et de l'Essayeur.

By L. Campredon. Second edition. Paris: Librairie Polytechnique, Ch. Béranger, 15, Rue des Saints-Pères.

The first issue of this practical guide for the metallurgical chemist and assayer was published about ten years ago, and the second edition has been revised, corrected, and enlarged. It is divided into three parts, the first of which gives general data, the second deals with the analysis of ores, metals, etc., and the third with numerical data. The first two chapters in the initial part treat of the taking and preparation of samples and the apparatus used and reactions which take place, the text being amplified by numerous illustrations. These are followed by chapters on the analysis and testing of fuel, gases, refractory materials, and water for industrial purposes. In the second part of the work the author considers the analysis of aluminium, antimony, silver, chrome, copper, tin, and iron and steel, the two latter occupying nearly 200 pages. The remaining chapters discuss the analysis of manganese, mercury, nickel, gold, platinum, lead, zinc, special metals, and alloys, whilst the final part cites a large amount of numerical data in relation to gases, acids, etc.

The Diseases of Workmen.

By T. Luson, M.D., and R. Hyde, M.R.C.S. With an introduction by His Honour Judge Ruegg, K.C. London: Butterworth & Company, 11 and 12, Bell Yard, Temple Bar.

The authors have divided their work into 24 sections, or chapters, comprising descriptions of as many diseases incidental to various trades. In each case particulars of the symptoms and distinguishing characteristics of the disease are presented in popular language that may be easily followed and understood. In their treatment of the subject the authors have practised compression to a marked extent, a feature which allows of the work being issued in a convenient size. In his introduction Judge Ruegg gives an interesting historical survey of the subject of workmen's compensation, leading up to an able legal exposition of the Act of 1906.

Metallic Alloys: Their Structure and Constitution.

By G. H. Gulliver, B.Sc., F.R.S.E., A.M.I.M.E. Charles Griffin & Company, Limited, Exeter Street, Strand.

The book on the above subject just published by Mr. Gulliver should prove a valuable addition to existing literature on alloys. The subject matter treated has formed part of a course of lectures on alloys, delivered in the Engineering Department of the University of Edinburgh recently, in which an attempt was made to present the theory of alloys on a systematic basis. The method of classification used is that which was adopted to some extent by Roberts-Austin and Stansfield, and the author of this book has tried to fill in the gaps which they left. The work is obviously not intended as a guide to the practical manufacture of alloys, except in so far as a knowledge of the equilibrium conditions and the unstable conditions of mixture will be of assistance in regulating their composition and heat treatment. In this respect the book should prove of material assistance to engineers and others dealing in alloys, for very little is yet known of the relations connecting the chemical constitution and the physical structure of an alloy with its mechanical and other properties.

The author opens by treating methods of investigation, the preparation of specimens, and the apparatus used therein. Coming then to the solution theory and the chemical equilibrium of mixed substances, alloys of solutions, mixtures of liquid and solid metals, freezing and melting point curves, and the equilibrium diagram are treated. A further chapter deals with binary alloys in which no definite chemical compounds are formed, and a further chapter is devoted to binary alloys which show evidence of the formation of definite chemical compounds. Equilibrium conditions in metallic mixtures forms the subject of another chapter, the phase rule and the transformation and metastable equilibrium in solid alloys being considered. Under the head of bronzes, brasses, and the steels, the copper-tin, copper-zinc, and iron-carbon alloys are considered, and, in conclusion, alloys of more than two metals are treated.

The book is not of such a nature as to render material assistance to the worker of alloys unless he is also to some extent a chemist and metallurgist, but to those with some knowledge of the science of metal-mixing, the different points elucidated will attach considerable value to the author's work.

QUERIES.

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A Strong Iron Mixture.

Can you inform me of an iron mixture of a very strong nature, with great resistance to shock, and easy to machine? The castings for which the iron is required are only small ones, weighing from a few pounds up to half a hundredweight. The average thickness is about ⅝-in., but in the same casting we have a body of metal about 2 in. thick, while at another point it is only ¼-in. thick. The heavy portion of the metal is in such a position that we cannot get to feed it, consequently the metal must be low in liquid contraction. Our present mixture consists of 3¼ cwts. Yorkshire (Lackenby), 1¼ cwts. Scotch (Carron), ½-cwt. hematite (Carnforth), and 5 cwts. scrap, principally our own re-melt. The average tests are as follows:—Shrinkage on ½-in. square bar, 12 in. long, in yokes equals 0.146; transverse test on bar 2 in. by 1 in. on 3 ft. centres equals 29 cwts.; deflection, 0.46. Will you please say what brands will give a stronger iron.

"SUBSCRIBER."

Shrinkage in Malleable Iron Castings.

We desire advice regarding the surest way to avoid shrinkage spots in malleable iron castings. It is especially pipe-fittings which cause us a lot of trouble. In the angles of all tees, L's, and crosses we almost invariably find shrinkage spots, although we hold the silicon as high as 1.15 per cent. Even if the iron is quite cold the shrinkage is there. The analysis of our iron is normal, with Ph 0.05, Mg 0.15, S 0.025, and total C 3.25 per cent. We have the fitting patterns mounted on a Berkshire machine and on Adams' squeezers, with air vibrators in the same fashion as is customary in the United States of America, and with large shrink balls.

"V. G."

NEW COMPANIES.

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BROOKES MANUFACTURING COMPANY, LIMITED.—Capital £1,000 in £1 shares, to carry on the business of engineers, etc.

FORSYTH, MILLER & COMPANY, LIMITED.—Capital £10,000 in £1 shares (5,000 preference), to acquire and carry on the business of Forsyth, Miller & Company, steel and iron founders.

R. R. ROBERTS, LIMITED.—Capital £5,000 in £1 shares, to acquire the business of engineer, machinist, ironfounder, and general metal worker, carried on at Woolford Iron Works, Bury.

MILLER & MACFIE, LIMITED.—Capital £6,000 in £1 shares, to take over the business carried on by C. Houston & Company, Stanley Engine Works, Kinning Park, Glasgow. Registered office: 20, Stanley Street, Kinning Park, Glasgow.

J. DAVY & COMPANY (ELSECAR), LIMITED.—Capital £4,000 in £1 shares, to acquire the business of ironfounders carried on by E. Davy, J. Davy, and F. Davy, as J. Davy & Company, at Elsecar, Yorkshire. Registered office: Elsecar Foundry, Elsecar, near Barnsley.

BARBER, WILSONS & COMPANY, LIMITED.—Capital £5,000 in £1 shares, to adopt an agreement with W. H. Wilson, and to carry on the business of brassfounders, etc., carried on at Westbury Avenue, N., as Barber, Wilsons & Company. Registered office: Westbury Avenue, Wood Green.

HATTERSLEY & DAVIDSON, LIMITED.—Capital £15,000 in £1 shares (7,500 preference), to take over the business carried on by Hattersley & Davidson, at 139, Norfolk Street, Sheffield, and elsewhere, and to carry on the business of mechanical engineers, etc. Registered office: 139, Norfolk Street, Sheffield.

DEATHS.

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MR. W. G. BRADLEY, for many years connected with R. Hornsby & Sons, Limited, Grantham, died recently.

THE death is announced of Mr. F. E. Smith, a director of Davy Bros., Limited, Park Iron Works, Sheffield, aged 83 years.

MR. J. STEWARDSON, of Messrs. Stewardson & Company, North British Copper Works, Edinburgh, died recently, aged 67 years.

THE death occurred recently of Mr. C. Wheeler, of Messrs. Wheeler & Hurst, iron and brass founders, Newport (I.W.), aged 82 years.

THE death is reported of Mr. J. R. Miller, of Messrs. Forsyth, Miller & Company, Glasgow Malleable Cast Steel Foundry, 44, Broad Street, Mile End, Glasgow, which took place at Glasgow on his eighty-fifth birthday, last week.

THE death is reported of Mr. J. T. Harris, at his residence, The Radfords, Stone. The deceased gentleman, who was well-known throughout North Staffordshire, was for many years managing director of the firm of Bullers, Limited, engineers, Hanley, but practically went into retirement two years ago, when the management passed into the hands of his son, Mr. J. W. Harris.

MR. C. NEALE MAY, of Seaton, Devonshire, died recently, aged 80 years. The deceased gentleman, over half-a-century ago, in conjunction with the late Mr. William Brown, started the North Wilts Foundry, Devizes. Mr. May learnt the business of engineering at the Reading Iron Works, at the same time as did the late Mr. William Brown. The friendship then formed led to the young men combining in the starting of the foundry at Devizes.

WE regret to announce that Sir Philip Albert Muntz, Bart., M.P., died recently at his residence, Dunsmore, Rugby, after seven months' illness, the result of a hunting accident. Sir Philip was educated privately, and at an early age entered his father's business. The early history of Muntz metal is exceedingly interesting. Towards the close of the eighteenth century the deceased gentleman's grandfather, Mr. Peter Muntz, bought a brass mill in Birmingham. He did not understand the cold-rolled brass trade, and the result was that he lost a good deal of money. But he kept the mill going until his death, in 1809, when the business became the property of his eldest son, George Frederick Muntz, the father of the subject of the present notice. At the time he succeeded to the business, George Frederick was only 16 years of age, but he was not content with manufacturing cold-rolled brass; he wanted a brass which could be rolled hot, and in the course of time he discovered an alloy which he named Muntz's metal of brass, and which could be rolled hot. This metal soon began to take the place of copper for sheathing wooden ships' bottoms, and the business developed rapidly. As the invention had been patented, Mr. Muntz had the market to himself for some years, but when he desired to renew the patent his application was opposed by all the copper sheet rollers in the country. The matter was fought out in a court of law, and Mr. Muntz lost his case, so that the patent was not renewed. Happily, this did not result in his ruin. It involved him in serious monetary difficulties, but shipbuilders and manufacturers continued to use the metal, and they preferred to place their orders with the man who invented it rather than with other people. Consequently, a great impetus was given to the business. While the Birmingham business was carried on as before, the new metal was made by Mr. Muntz, in conjunction with Mr. Pascoe Grenfell, at Swansea. The works remained in Wales for some years, but considerably more than 60 years ago they were removed to the French Walls Works, Smethwick, and there the business has been continued and developed ever since. In 1884 the Muntz Metal Company, Limited, was created, and Sir P. A. Muntz became the senior managing director and chairman—a position which he held at the time of his death. The baronetcy was conferred on him in 1902.

Inventions.

Applications for Patents.

—o—

An asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

—o—

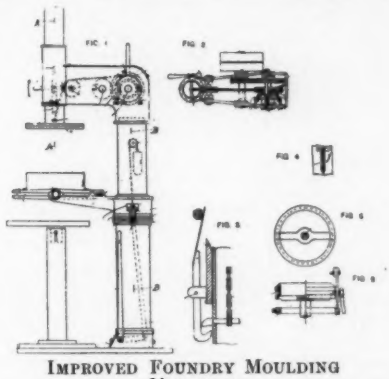
1908.

23,494.*Core supports for use in moulding and casting. A. Gärtner.
23,592.*Ingot-casting machines and methods of preventing "piping" of ingots. L. E. Howard.
23,772. Alloy of aluminium and other metals. J. E. Wiggin, Lichfield Road, Bloxwich.
23,958.*Cementation of iron, soft steel, cast steel, etc. E. Jouard.
24,007. Preparation of iron or steel for casting. (Chemische Fabrik Griesheim Elektron, Germany.)
26,101. Metallic alloy. A. Gutensohn, 4, Mitre Court, Temple, London.
26,176. Process of hardening aluminium. H. A. Lawrence and C. E. Knight.
26,356. Electric furnaces. C. Bingham.
26,380.*Metallic alloys. D. Landenberger.
26,431.*Core drilling apparatus. C. A. Terry.
26,493. Alloy for projectiles and a process for the production of the same. A. Churchward.
26,521.*Process for rust prevention on iron and steel. Langbein-Pfanhauser-Werke Akt.-Ges, Prudential Buildings, Corporation Street, Birmingham.
26,559.*Casting pipes. E. A. Custer.
26,560.*Structure-lifting devices for casting moulds. E. A. Custer.
26,826. Silicon alloys. (General Electric Company, United States.)

Abstracts of British Patent Specifications recently accepted.

23,930 (1907). *Improvements in Foundry Moulding Machines.*—T. F. Evans, of the Britannia Works, Cross Street, Blackfriars, Salford, and R. McGregor, of 3, Lightbourne Avenue, Leigh. The moulding machines to which this invention relates are of that kind in which in order to compress sand or other moulding material a tup or hammer-head of suitable area and form, and, if desirable, adjustable by change of parts or by other means, is mounted in guides upon or in an arm or frame forming part of a moulding machine, and is adapted to be raised from and allowed to fall or move to strike the sand to be acted upon by means by which the necessary reciprocatory motion of such tup or hammer-head may be obtained, in order that whenever necessary or desirable a series of blows may be exerted upon the sand or other moulding material.

The first part of this invention relates more especially to that class of moulding machine in which a tup or hammer-head is made to act upon moulding material in a moulding box upon a turn-over-table or plate to carry a pattern, and consists in the application in combination with such a tup and turn-over-table, of a table provided in order that a turn-over-table on which sand is to be rammed at any time may be placed upon it so as to be supported while sand is being rammed by means of the tup or hammer-head, and so as to enable moulding boxes to be held steady while sand is being rammed therein. Fig. 1 is a side elevation of the moulding machine with certain parts omitted to obviate confusion, and Fig. 2 is a plan of the upper part of such machine with a cover-plate removed in order that some of the mechanism within the machine may be better shown. Fig. 3 is in part a front elevation and in part a vertical section taken on the plane indicated by the line A A of Fig. 1, showing particularly the catch provided to



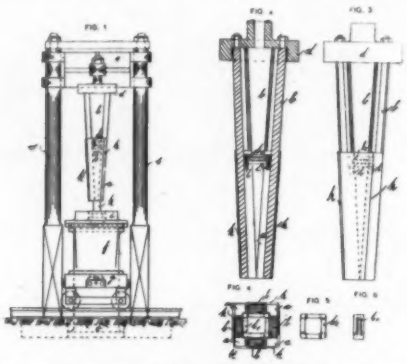
IMPROVED FOUNDRY MOULDING MACHINE.

hold up the tup or hammer-head. Fig. 4 is a side elevation of a portion of a pillar employed in the machine. Fig. 5 is in part a front elevation and in part a vertical section on the plane indicated by the line B B of Fig. 1 showing certain parts shown in Fig. 1 and parts used therewith. Fig. 6 is a plan of certain of the parts shown in Fig. 5.

24,517 (1907). *Improvements in and relating to Processes of Melting in Electric Furnaces and their Application to the Extraction of Easily Volatilizable Metals.*—H. Herrenschmidt, of 10, Boulevard Magenta, Paris. It is well known that owing to the high temperatures developed by the voltaic arc, the electric furnace cannot be used under ordinary conditions for producing metals or bodies in a liquid state, the boiling point of which is comparatively low, unless electric furnaces are resorted to that are provided with special devices such as described in Letters Patent No. 8288/1902. The present invention consists chiefly in inserting between the source of heat, *i.e.*, the electric arc and the material to be treated placed within the furnace, a protecting layer or screen which absorbs part of the heat produced by the arc by way of endothermic physical and chemical reactions so that the heat supplied to the material to be treated is sufficient to melt the same, but insufficient to cause its subsequent evaporation. The protecting layer or screen referred to is formed by a slag produced by the fusion of refractory materials the density of which is less than that of the body to be treated, so that the slag constantly places itself between the body to be treated and the electric arc.

22,921 (1907). *Improvements in Moulding Machines for Chilled Castings.*—K. Grote, electrician, of 28, Adlerstrasse, Dortmund, Germany. The stamping down of the moulding sand is entirely obviated by this method. When the pattern is withdrawn, the mould remains undamaged, and a clean mould, particularly suited for chilled castings can be prepared within a few minutes. Fig. 1 represents a front view of the moulding machine; Fig. 2 a longitudinal section of the model or form; Fig. 3 a lateral view of the same; and Figs. 4 to 6 a section and details of the same. When a mould is to be prepared, the truck with the flask and the top is run beneath the pattern suspended

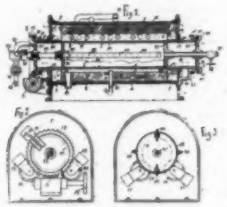
on the holder. If the hydraulic force acts on top of the press-cylinder *c*, the cross-piece *e* with the pattern *a* will descend, until it strikes against the bottom of the flask. The empty space between the pattern *a* and the flask *f* is filled up with mould sand. Then the piston-rod is caused to still further press the pattern down-



GROTE'S IMPROVED MOULDING MACHINES FOR CHILLED CASTINGS.

wards, the arms *b* are forced downwards through openings in the bottom of the truck, and the pattern *a*, which now rests upon the bottom is forced uniformly into all directions until the cover-plate *d* penetrates the top *i* of the flask. By this manipulation the sand has been firmly pressed together. In removing the pattern from the finished mould, the working order is reversed.

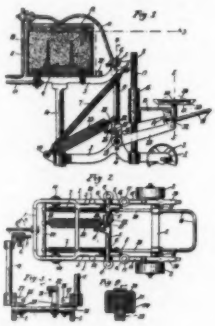
25,087 (1907). *Improvements in or relating to the Case-hardening of Steel and Iron Articles.*—A. W. Machlet, of Spring and Lafayette Streets, Elizabeth, New Jersey, U.S.A. The articles are heated to a point above redness, but below the melting point in an atmosphere of carburising gas, preferably above atmospheric pressure. A gentle agitation of the articles is effected during the cementation, so as to expose all portions of the articles to the action of the gas. The heat may be from about 1,500 to about 1,800 degrees F. In the preferred man-



APPARATUS FOR CASE-HARDENING IRON AND STEEL ARTICLES.

ner of practice ammonia gas is led from a tank through a body of naphtha, the ammonia taking up a quantity of naphtha, and being then led into the retort or oven to carburise the articles; the ammonia serving as a diluent for the carburising gas which it derives from the naphtha, and avoiding the deposit of free carbon upon the articles, and hastening the carburising operation. Fig. 1 represents a sectional elevation taken from end to end of one form of an apparatus constructed for case-hardening and tempering articles according to the invention. Fig. 2 is an elevation of the left-hand end, and Fig. 3 an elevation of the right-hand end of the carburising apparatus seen in Fig. 1.

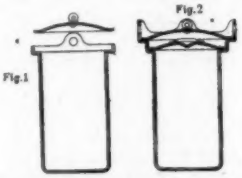
3,072 (1908). *Improvements in Moulding Machines.*—H. E. Pridmore, of 204, Dearborn Street, Chicago, U.S.A. This invention relates to moulding machines of the marginally hinged and turn-over table type wherein the table with its flask and cover plate, in the act of being turned over is transferred from one side of a vertical support, where it is held whilst being rammed, to a flask carrier at the other side thereof. The invention has for its object to provide a machine of this character in which the pivotal point is stationary and the necessary accommodation, within certain limits, of flasks of different depths hitherto secured by reason of the movable pivot aforesaid, obtained by making the flask car-



PRIDMORE'S MOULDING MACHINES.

rier movable so that it will automatically adjust itself to the varying inclination of approach of the flask cover plate towards the carrier due to difference in the flask depth or other irregularity, means being additionally provided for positively altering the limit and for positively moving the carrier to draw the pattern. Fig. 1 is a view in part section showing one form of a machine embodying the invention; Fig. 2 is a sectional view taken on line 3—3 of Fig. 1; Fig. 3 is a sectional view taken on line 4—4 of Fig. 1; Fig. 4 is a sectional view taken on line 5—5 of Fig. 1.

8,171 (1908). *Improved Wrought Iron Annealing Pot.*—E. T. Lammine, manufacturer, of 26, Schönratherstrasse, in Mülheim a/Rhine, Germany. Hitherto known annealing pots have the disadvantage that the riveting means become loose after the pot has been used, and air penetrates into the pot. Cast steel pots are also not practicable owing to the great weight and consequently



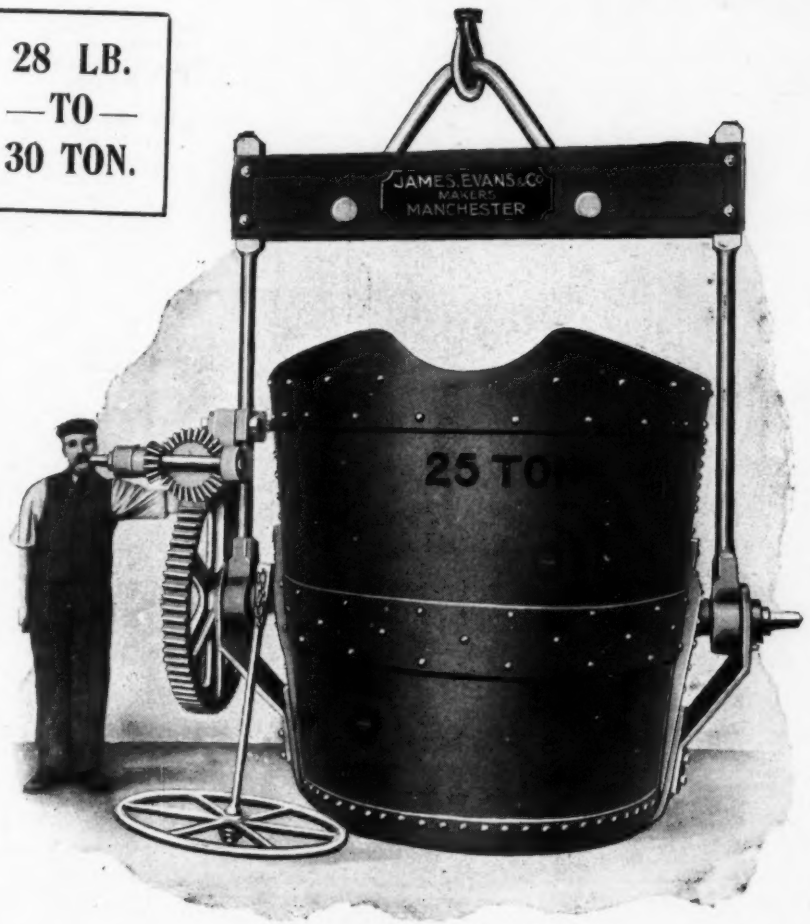
WROUGHT IRON ANNEALING POT.

the inconvenience in transporting same. The present pot sets aside all these deficiencies, and is made out of welded wrought iron, the walls being bent out at right angles at the top to form a flanged rim on which the cover fits. This rim is, therefore, of one piece with the pot, and has lifting lugs formed on it out of the metal of the rim. Fig. 1 shows a sectional elevation of the pot and cover with the flange, and Fig. 2 shows the same with two covers and two flanges.

HADFIELD'S STEEL FOUNDRY COMPANY, LIMITED, Sheffield, have recently opened an office in Mexico, where they are attempting to secure a part of the Mexican demand for iron and steel goods in competition with our hustling American cousins. We understand that Wm. Jessop & Company, Limited, are also actively pursuing a like policy.

FOUNDRY LADLES.

28 LB.
—TO—
30 TON.



JAMES EVANS & CO., BRITANNIA WORKS,

TELEGRAMS—
"LADLES, MANCHESTER."
TELEPHONE—2297.

BLACKFRIARS, MANCHESTER.

TRADE TALK.

Mr. E. H. Judd, of 68, Gordon Street, Glasgow, announces that he has been appointed sole Scottish representative for H. W. Ward & Company, Limited, machine-tool makers, Birmingham.

Nasmyth, Wilson & Company, Limited, of Patricroft, near Manchester, are at present constructing for the Assam-Bengal Railway three tank locomotives, which are to be ready for shipment next April.

A dissolution of partnership is notified in connection with Messrs. W. Donald and E. Shelton, general engineers, Newark-on-Trent, Notts, who traded under the style of Donald & Shelton.

At a meeting of the Tangye Memorial Committee, held at Birmingham, recently, Mr. Whitworth Wallis reported that the memorial had been completed and placed in the entrance hall of the Art Gallery. The memorial is to commemorate the services to Birmingham of Sir Richard and Mr. George Tangye. It is a handsome bronze plaque, containing the portraits of the two brothers, and is mounted on green marble.

Meldrum Bros., Limited (in liquidation), of the Engineering Works, Timperley, near Manchester, notify us that there appears to be an impression abroad that their works are now closed, which impression might prejudicially affect the business. We are asked to state that the works have been running all along under the personal supervision of Mr. John W. Meldrum, and the company are executing all orders for replace parts and repairs, as well as receiving further orders for destructors, furnaces, etc., pending re-construction, which they hope may be completed before very long.

The second meeting of the Institute of Metals will be held on January 19 and 20, 1909, at the hall of the Institution of Mechanical Engineers, London. The papers to be discussed include the following:—"The Mechanism of the Annealing Process of Certain Alloys," by Messrs. Bengough and Hudson; "The Nature of Inter-Metallic Compounds," by Dr. Desch; "Aluminium, and Some of its Uses," by Mr. Echevarri; "Some Points of Interest Concerning Copper and Copper Alloys," by Mr. J. T. Milton; "Some Notes on Phosphor Bronze," by Mr. Philip; "Plant Used in the Manufacture of Tubes," by Mr. Robertson; "Metallographic Investigation of Alloys," by Mr. Rosenhain.

PERSONAL.

Mr. J. W. Blake, of Messrs. J. W. Blake & Company, Gosport, has been appointed a J.P. for Hants.

Mr. W. H. Turner has been elected a director of J. & C. Wright, Limited, in place of the late Mr. W. Williams.

Colonel Pilkington, of Pilkington Bros., Limited, St. Helens, has been appointed Deputy-Lieutenant for Lancaster County.

The gross value of the estate of the late Mr. T. Colley, of Clyde Terrace, Spennymoor, Durham, retired ironfounder, is £5,233.

Mr. G. Whale, chief mechanical engineer of the London and North-Western Railway Company, has tendered has resignation owing to ill-health.

The late Mr. J. H. Holman, engineer and ironfounder, of Holman Brothers, Limited, Camborne, left estate valued at £71,212 gross, with net personalty £70,836.

Mr. Edgar Jobson, managing director of the Derwent Foundry Company, Derby, was recently entertained at a complimentary banquet by the members of the Derby Chamber of Commerce, upon the completion of his three years' term of office as President.

Mr. J. Maddison, formerly general secretary of the Friendly Society of Ironfounders, has been the recipient of an illuminated address from the Management Committee of the General Federation of Trade Unions in recognition of his services.

Mr. F. Herbert, of the Birtley Iron Company, Limited, Newcastle, accompanied by his son, is now in the United States, for the purpose of making arrangements for the erection of the new cast-iron pipe foundry of J. B. Clow & Son, Coshocton, Ohio.

The West Hartlepool Town Council recently resolved to recognise the eminent services to the Borough rendered by Sir Christopher Furness, M.P., by asking him to accept, as a slight acknowledgment of his efforts, the honorary freedom of the Borough.

Mr. J. R. Yates died, recently, at his residence, Church Road, New Mills, Yorks. The deceased, who was about 38 years of age, was the active partner in the firm of Edward Yates & Sons, brassfounders and engineers. He was the inventor of several useful pieces of mechanism, and was well known in the engineering world.

GANISTER, CUPOLA BLOCKS, FIRE BRICKS,
FIRE CLAY.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
STEEL MOULDERS' COMPOSITION, SILICA CEMENT.
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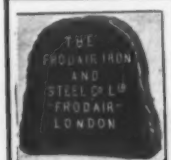
DEEPCAR, nr. SHEFFIELD.
Telegrams: "LOWOOD, DEEPCAR."



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BROKEN CASTINGS.

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NOW OPEN.

ESTIMATES FOR WORK AND ILLUSTRATED PAMPHLET upon application to

THERMIT LIMITED,

27, Martin's Lane, Cannon Street, E.C.

ELDERS FOUNDRY COKE

AS SUPPLIED TO THE BRITISH ADMIRALTY DOCKYARDS.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.

We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blowholes and other defects, than we formerly did.

From MOUNTFORD PHILLIPS & CO., Llantrissant.

Llantrissant, October 25th, 1904.

In reference to the Foundry Coke you have been supplying us with for the last six months, we have very great pleasure in letting you know that it has given every satisfaction, and that our Works Manager and Workmen give it the highest praise.

Elders Navigation Collieries, Ltd., Cardiff.

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years :—

METALS.	End Dec., 1908.	End Dec., 1907.
Iron—Scotch pig warrants ton	*55 3	*57 6
—Middlesbro' warrants ton	49 2	48 7
—W.C. Mines Bessemer ... ton	58 6	67 0
—Stock, Scotch ... tons	1,060	1 174
Copper—Chili bars, GMB ton	£63 15 0	£61 17 6
—Stock, Europe and afloat tons	53,631	19,710
Tin—English ingots ... ton	£132 5 0	£125 10 0
—Straits ... ... ton	£132 5 0	£121 0 0
—Stock, London, Holland, and afloat ... ... tons	20,544	12,452
Lead—English pig ... ton	£13 8 9	£15 2 6
Spelter—Ord. Silesian ... ton	£21 0 0	£19 5 0
Quicksilver (75lb)... bottle	£8 10 0	£8 4 6
Antimony—Regulus .. ton	£32 10 0 £31 10 0	£33 0 0 £35 0 0

* Settlement price.

CASTINGS.

In the Cleveland district the following are the nominal rates current for castings :—

	£ s. d.		£ s. d.
Columns (plain)	6 15. 0	to	7 0 0
Pipes, 1½ to 2½ in.	5 2 6	to	5 7 6
,, 3 to 4 in.	4 15 0	to	5 5 0
,, 5 to 8 in.	4 12 6	to	4 15 0
,, 10 to 16 in.	4 12 6	to	4 15 0
,, 18 to 24 in.	4 12 6	to	4 15 0
Chairs	3 10 0	to	3 12 6
Floor plates (open sand)	3 0 0	to	3 5 0

SCRAP.

The quotations for scrap, subject to market fluctuations. are as follows: —Heavy wrought (mixed), £2 5s. 0d.; light wrought, £1 1s. 0d.; heavy cast, £2 6s. 0d.; all per ton f.o.b., London. Copper (clean), £57 0s. 0d.; brass (clean), £41 0s. 0d.; lead (usual draft), £12 5s. 0d.; tea lead, £10 10s. 0d.; zinc, £16 10s. 0d.; all per ton delivered merchant's yard.

MESSRS. H. B. BARNARD & SONS, of 53, Gracechurch Street, London, E.C., have taken new offices at 59/60, Gracechurch Street, E.C.

MESSRS. J. J. WALKER and A. W. WALKER, iron and brass-founders, Mansfield, Notts, trading under the style of Samuel Walker & Sons, have dissolved partnership.

THE ECLIPSE TOOL MANUFACTURING COMPANY have just placed contracts for the erection of new works at Linwood, near Johnstone. This company only started operations a few years ago.

THE INTERNATIONAL TIME RECORDING COMPANY, of 151. 153, and 155, City Road, London, E.C., have received a repeat order from Fried. Krupp, Essen, Germany, for 50 International card time recorders, making 160 now in use at these works.

J. DAMPNEY & COMPANY, LIMITED, of Cardiff, have opened their own offices in London at 72, Bishopsgate Street, E.C., under the management of Mr. R. H. Turpin who was with their late agents, Messrs. Arthur Slator & Company, for a period of 14 years. The company's telegraphic address will be "Apexior, London."

SILICA FIRE BRICK Co.,

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GROUND GANISTER,

WET OR DRY.

Silco Cupola Bricks, 90% Silica.

Better than Fire-clay Bricks for Cupolas.

Established 1863.

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PHŒNIX WORKS, PENISTONE, Near Sheffield.

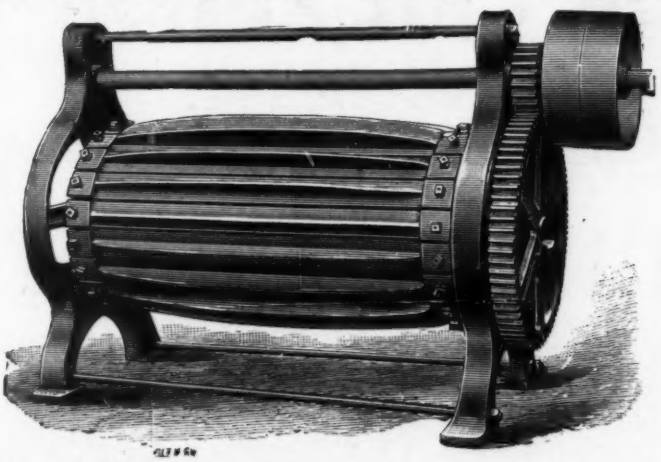
Manufacturers of all

FOUNDRY EQUIPMENTS,

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST.

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

IMPROVED FOUNDRY RATTLER or FETTLING DRUM.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD."

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THE NEW FOUNDRY CEMENT.

IT is used for filling up blowholes and sand holes in Cast Iron or Steel Castings.
IT is supplied in powder form and mixed for use with a little water to a stiff paste.
IT dries on a casting in 1 hour, and can be filed up bright in from 6 to 12 hours.
IT is specially useful to all Engineers, Machinists, Foundrymen, etc.
IT is of British Manufacture.

A Small Sample sent Post Free on Receipt of your Address, or a trial 1 lb. Tin Post Free on receipt of P.O. or Stamps for 1s. 4d.

THE SILENT MACHINE & ENGINEERING CO.,

2, Savile Street, SHEFFIELD.

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STEEL FOUNDRY MANAGER or HEAD FOREMAN (48) desires engagement; nine years' experience in present situation; thoroughly conversant with compos. and paints; also possessing a wide and varied knowledge of steel castings from a few pounds up to 25 tons. Thoroughly capable of taking charge of men, and possessing a wide knowledge of piecework prices and up-to-date foundry practice. Full particulars of records and references on application.—Address Box 200, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

FOR SALE AND WANTED.

ONE ROOTS' BLOWER, No. 10, capacity 19,400 cubic feet of air per minute; never been used; low price, immediate delivery.—Apply FRASER & FRASER, LTD., Bromley-by-Bow, London, E.

FOR SALE, SMALL IRONFOUNDRY, with Gas Engine, Fan-Blast, Emery Wheel, etc.; every facility, genuine connection. Bargain, £125.—COLLINGS, 25, Carlyle Road, Greenbank, Bristol.

MESSRS. C. A. ROBINSON & CO., Anchor Iron Wharf, East Greenwich, S.E., are Cash Buyers of every description of Scrap Iron and Steel, Brass, Copper, and all Metallic Residues. Telephone, 94 Deptford.

SECOND-HAND.

BLOWING FANS.—One each 25 in. disc by 12 in. outlet; one 40 in. by 18 in., by Gunther; 11 in. by 5½ in., by Sturtevant Co.; 18 in. by 8 in., by R. Loyd & Co.

ROOTS' BLOWERS.—Size H, by Samuelson, and No. 2 by Thwaites.

SAND GRINDER.—4 ft. dia., with outside bearings, by Smedley Bros.

ASH WASHER for Brass Ashes, Mayer's Patent, 32 in. dia.

RUMBLING BARREL for Brass Castings, 22 in. dia.

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THE "ECLIPSE" SAND MIXER and GRINDER is the Best for utilising Old Sand, Core Sands, Loam, and other Materials, mixed and prepared at lowest cost.—Apply HALL'S ENGINEERING CO., Hounds Gate Buildings, Nottingham.

NOTICE.

CARNEGIE RESEARCH SCHOLARSHIP.

THE Council of the Iron and Steel Institute will shortly proceed to AWARD the RESEARCH SCHOLARSHIP, founded by Mr. Andrew Carnegie. Candidates, who must be under 35 years of age, must apply before January 28 on Special Forms to be obtained from

G. C. LLOYD,
Secretary of the Iron and Steel Institute.
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Also Machine Shop, about 90 ft. by 33 ft., containing large Lathes for dealing with heavy work up to 12 ft. diameter; Planing, Drilling, Slotting, and Shaping Machines, etc.

Also Forge, about 40 ft. by 53 ft., containing 8 Hearths, 4 Power Hammers, Plate-bending Rolls, massive Punching and Shearing Machines, etc.

Also Pattern Shops, Offices, and Stores, completely equipped.

There is about half of an acre available for extensions.

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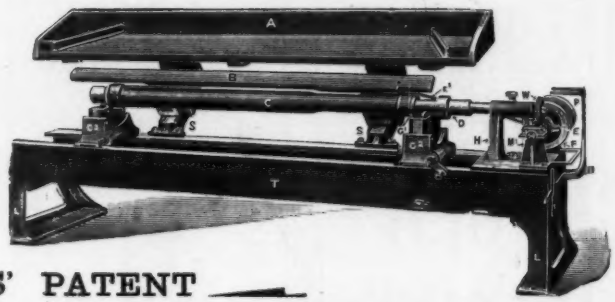

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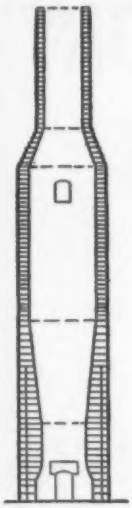

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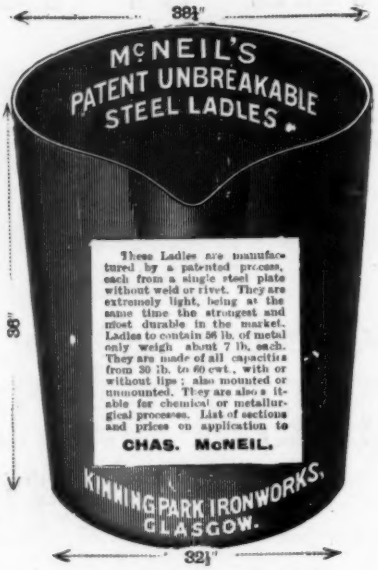
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These Ladles are manufactured by a patented process, each from a single steel plate without weld or rivet. They are extremely light, being at the same time the strongest and most durable in the market. Ladles to contain 56 lb. of metal only weigh about 7 lb. each. They are made of all capacities from 30 lb. to 60 cwt., with or without lips; also mounted or unmounted. They are also adaptable for chemical or metallurgical processes. List of sections and prices on application to
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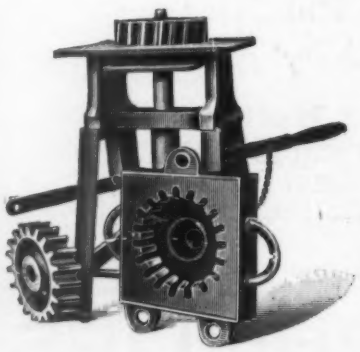

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The advantages of these Machines over the ordinary methods of Moulding are so great that no foundry which has any call for repetition work should be without them. The saving in labour alone in many cases reaches as much as 75 per cent, and the castings are much more accurate, being exact duplicate of each other, and with scarcely any fin at the joint. No skilled labour is required, it is simply necessary to shovel in the sand and ram it, lower the lever, and remove the Moulding Box. There is no rapping of the Pattern required, no patching nor sponging, and the time occupied is but a fraction of that required in the ordinary manner of moulding.

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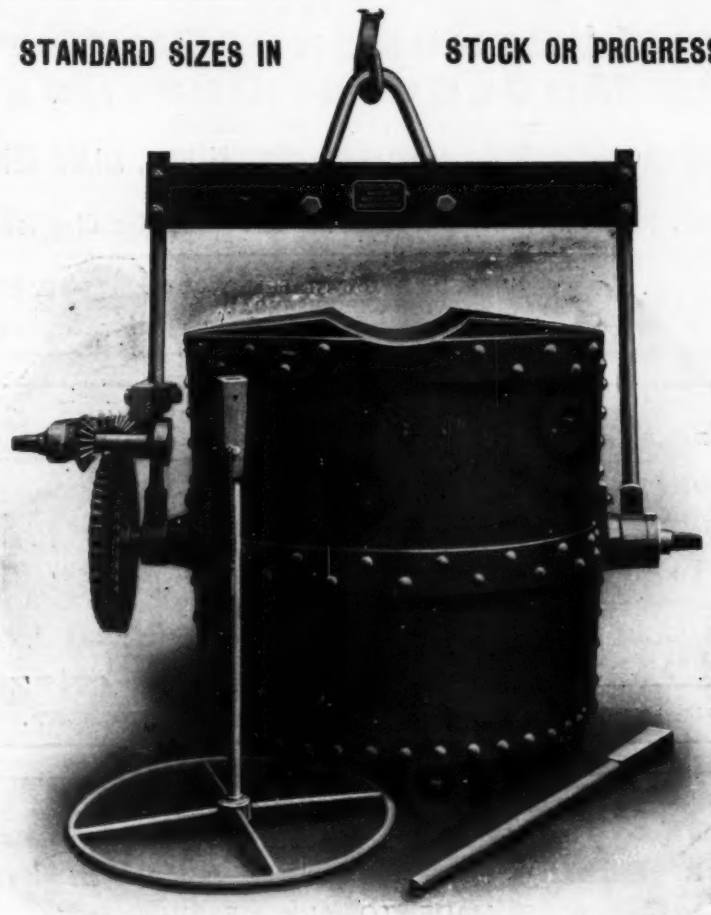

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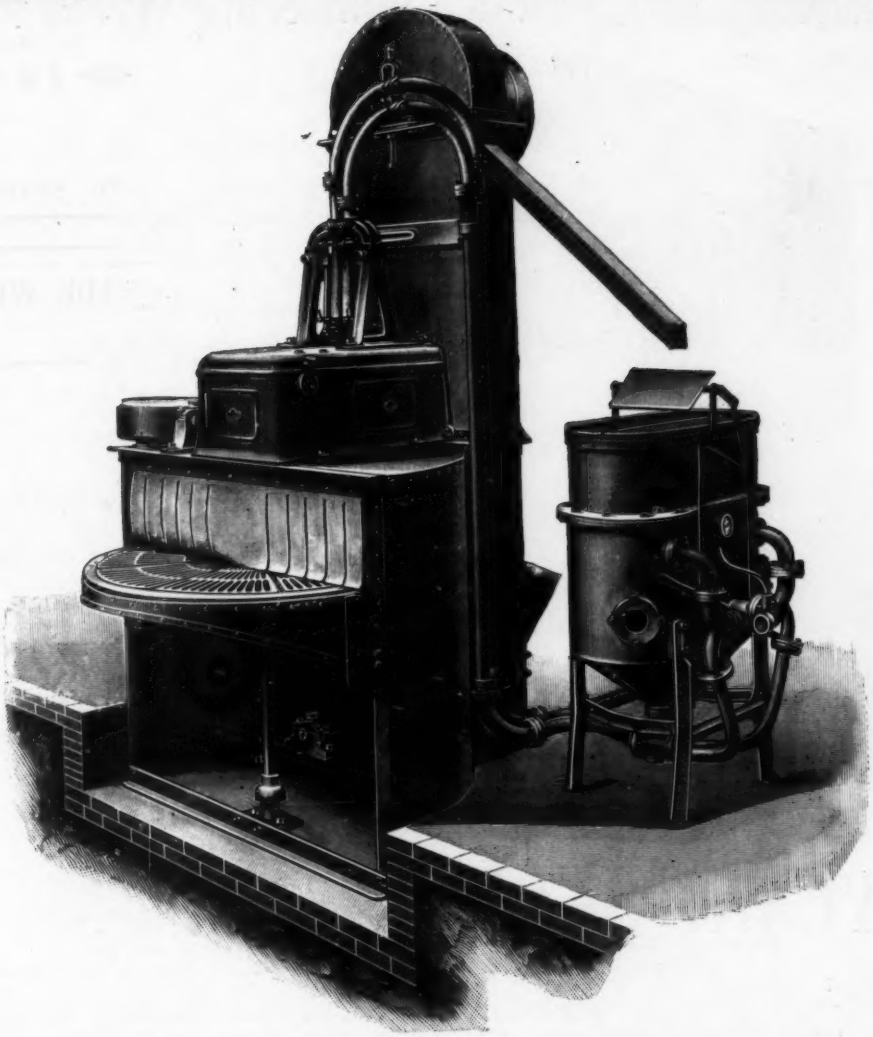

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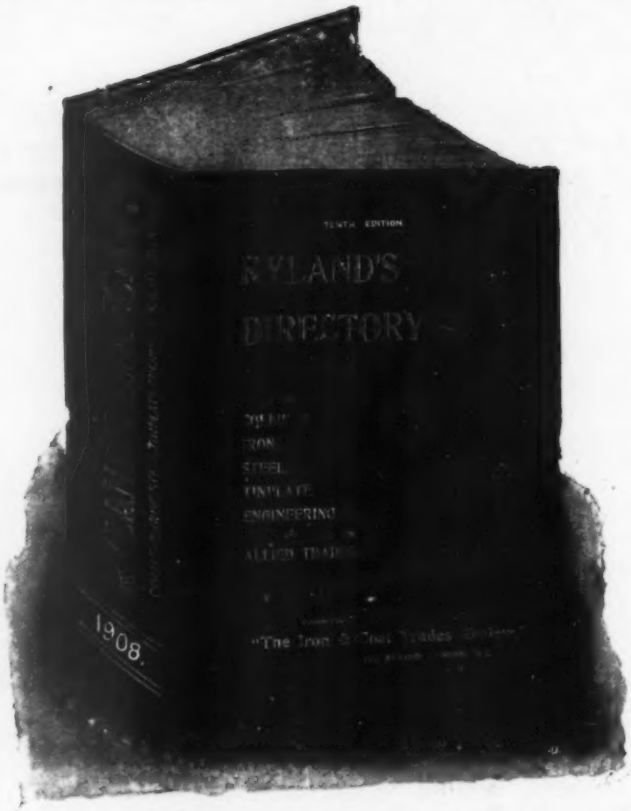

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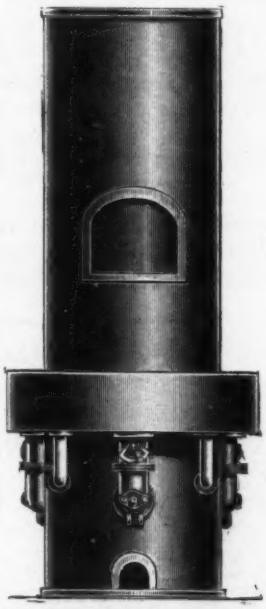

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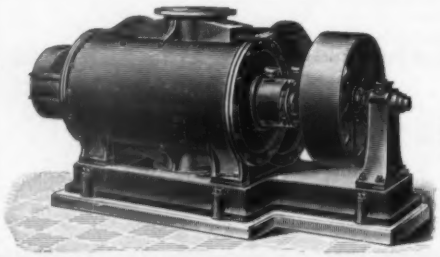

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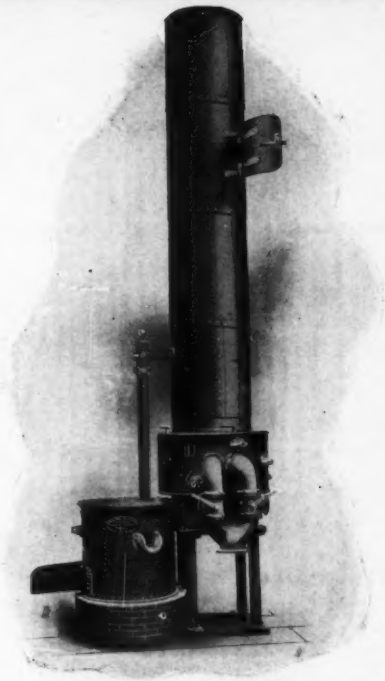

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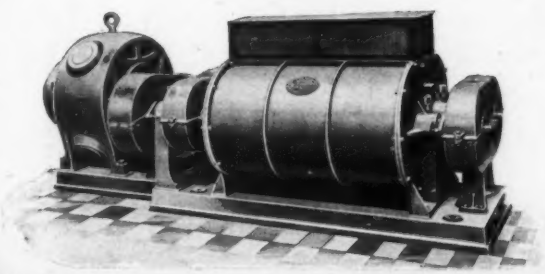

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